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VOL. 1

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PARACHUTE RIGGER

VOL. 1

PREPARED BY
BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSES
NAVPERS 10356

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PREFACE

This book is the first of two volumes on parachutes. It is written for the enlisted men in Naval Aviation, and is one of a series of publications designed to furnish the technical information necessary for the performance of aviation duties.

A knowledge of parachutes and other lifesaving equipment, including life rafts, life vests, and CO_2 and oxygen units, is required of Parachute Riggers. Men of this rating are responsible for the maintenance of these materials; the lives and safety of those who man Naval aircraft depend on their work.

This volume begins with a history of the parachute and continues with an explanation of forces encountered when a parachute is put into use. Attention then turns to the many designs used in service, with discussions on assemblies, loft set-ups, inspection, and repairs. In volume 2 fasteners, sewings machines, and the packing and rigging of parachutes are described in detail. Also included is information on drop testing and jumping procedures. The book concludes with chapters on cargo chutes and safety belts.

As one of the NAVY TRAINING COURSES, this book represents the joint endeavor of the Naval Air Technical Training Command and the Training Division of the Bureau of Naval Personnel.

READING LIST

NAVY TRAINING COURSES

Parachute Rigger, Vol. 2, NavPers 10357
Aircraft Survival Equipment, NavPers 10352
Introduction to Aircraft, NavPers 10303–A
Aviation Supply, NavPers 10394–A
Use of Tools, NavPers 10623

OTHER PUBLICATIONS

Parachute Manual, NavAer 13–5–501
Naval Aircraft Oxygen Equipment Handbook,
NavAer 03–50–517

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PARACHUTE RIGGER

Vol. 1

CHAPTER 1

THE PARACHUTE

ITS IMPORTANCE

The parachute is designed to bring the endangered flier safely to earth. To perform this function one hundred percent of the time, expert care and great pains in handling and maintenance are necessary.

As a Parachute Rigger you are responsible for all life-saving equipment used in aviation. It is your duty to make certain that the parachute and its related units are constantly in readiness for perfect operation. Your work demands thorough knowledge and perfect execution for there is no "second chance" where life is at stake.

Naval aeronautical regulations require all personnel to wear or carry parachutes when flying in training and combat aircraft. The safety of the crew is of primary importance, demanding first consideration in peace or war, and you are the one who makes that safety possible.

THE PARACHUTE RIGGER

In order to save a man's life, a parachute must open, which means simply that the chute must be in perfect working condition. Making and keeping parachutes in such a state of readiness is your duty, and in the performance of that duty, you must take no chances. You must at all times know WHAT you are doing, and you must understand the REASON for every action. You must be thoroughly familiar with the construction of parachutes as well as the mechanical principles which govern their proper functioning.

You must learn to pack a chute so that it will open and operate successfully EVERY TIME. Because you are responsible for maintenance, you must be able to care for parachute fabrics, repair damaged equipment, and inspect and test lifesaving gear to make certain that no operating failures could develop.

There are also times when you must devise ways and means of making cargo chutes for lowering food, medicine, armament, and ammunition to isolated areas and units.

But parachutes are merely the beginning of your responsibilities. There are many other items of lifesaving equipment designed for flying personnel. You must know how to maintain, equip, and pack all types of life rafts, life vests, safety belts, shoulder harnesses, flight gear, and anti-blackout suits.

The operation of a sewing machine must be second nature to you. You must be thoroughly familiar with the various types of fabrics. You are also responsible for the maintenance and repair of the numerous types of sewing machines with which you work.

PARACHUTE BACKGROUND

As far back as 1495, Leonardo da Vinci designed a parachute consisting of a pyramid of cloth. Many of da Vinci's theories have been incorporated in modern chutes.

In 1617, Fouste Veranzio jumped from a tower in Venice, using as a parachute a square, wooden framework covered with canvas.

This brief bit of background discloses that the idea of parachutes is not by any means new. It also indicates that the numerous devices of yesteryear were devised simply as forms of amusement. The possibilities of parachutes for the purpose of saving lives never occurred to any early designer for the reason that no need for an aerial lifesaving device existed.

Interest in parachutes was renewed in 1783, however, when the Montgolfer brothers succeeded in making a balloon. In order to maintain the necessary supply of hot air to keep the balloon aloft, aerial navigators often burned bundles of straw beneath the bag. If the fabric caught fire the flight was abruptly ended. The fact that men went aloft, and the fact that such flight often made quick escape and descent imperative, removed the parachute from the stunt classification. In 1808, a Polish balloonist named Kuparento became the first aerialist to leap to safety with a parachute from his blazing bag of hot air.

For nearly a century following Kuparento's jump, however, the need for foolproof chutes was never seriously recognized. But when the Wright brothers, in 1903, stayed aloft in their primitive plane at Kitty Hawk, the Air Age came into being, and the parachute left the sideshow to become, once and for all, an integral part of aviation.

Following the appearance of the airplane, there was a period of experimentation with parachutes peculiarly designed for the new type of aircraft, since the old balloon-type chute constantly fouled in the swifter-moving airplane.

The first successful jumps from aircraft were performed with makeshift chutes. Grant Morton jumped from a plane carrying a loosely-folded chute in his arms. After clearing the plane, he tossed the bundle of silk to the breeze where it caught and billowed. In 1912, Capt. Albert Berry made a jump with a loaded parachute. The chute was packed in a cone-shaped metal cylinder and attached to the underside of the fuselage, just over the axle. Berry crawled from the cockpit to the axle and slid onto a trapeze bar which served as a "harness." When he jumped, the weight of his body pulled the chute from the container.

During World War I, balloonists became observers, and because such duty was highly hazardous, these aviators wore parachutes. The record shows that the lives of 800 balloonists were saved by parachutes during the first World War.

Parachutes were not considered essential equipment for World War I aviators, and less than one-hundreth of one percent of aerial missions made during that struggle were flown by pilots wearing chutes. Because of this, the mortality among pilots on active duty at the front was very high. As a result, the need for an efficient, emergency man-carrying parachute became a primary requirement between 1916 and 1918, and both belligerents set about developing suitable chutes.

Consequently, out of World War I came varying types of parachutes — the *Heinecke* (German), the *Mears* and *Guardian Angel* (British), the *Orrs* and *S.T.A.* (French), and the *A.E.F.* (American). All these chutes were heavy and unwieldy, and none was safe at speeds exceeding 100 miles per hour.

It was an accepted fact that parachutes could save lives if they worked. The next logical step was that of rendering them foolproof.

FOOLPROOFING PARACHUTES

Following the first World War, work on the development of parachutes was continued, chiefly at the Army Air Service Experimental Station at McCook Field in Dayton, Ohio.

Experience had shown that the attached type of parachute was wholly unreliable as an emergency unit, mainly because of the unpredictable paths taken by disabled planes. Inverted positions, spins, or rates of speed played havoc with attached-type chutes. In 1919, after painstaking research and experimentation, a free-type parachute emerged that enabled the operator to release the canopy from a pack AFTER HE HAD JUMPED. Test after test with dummies proved that this type of chute worked EVERY TIME.

Three years passed from the development of the free-type parachute to the successful demonstration of its value in saving a pilot's life. While flying over McCook Field in 1922, Lt. R. H. Harris subjected his plane to such violent maneuvers that the wings were torn off. Harris bailed out, and his parachute brought him safely to earth.

Further experiments improved the parachute and produced the back, seat, chest, and lap styles. The successful parachute — termed TYPE S — was deemed completely foolproof, and in 1924, orders were issued requiring all Navy and Army fliers to wear this design.

QUIZ

1. The maintenance of sewing machines is a duty performed by
   - *a.* Instrumentmen.
   - *b.* Machinery Repairmen.
   - *c.* Mechanics.
   - *d.* Parachute Riggers.
2. The first parachute was designed about
   - *a.* 50 years ago.
   - *b.* 150 years ago.
   - *c.* 250 years ago.
   - *d.* 450 years ago.
3. The first parachute jump was performed about
   - *a.* 30 years ago.
   - *b.* 50 years ago.
   - *c.* 330 years ago.
   - *d.* 450 years ago.
4. The first parachute jump was made from
   - *a.* an airplane.
   - *b.* a balloon.
   - *c.* a tower.
   - *d.* a cliff.
5. The first person ever to use a parachute to save his life was
   - *a.* Kuparento.
   - *b.* Montgolfer.
   - *c.* Berry.
   - *d.* Leonardo da Vinci.

6. During World War I, parachutes were used extensively by ....

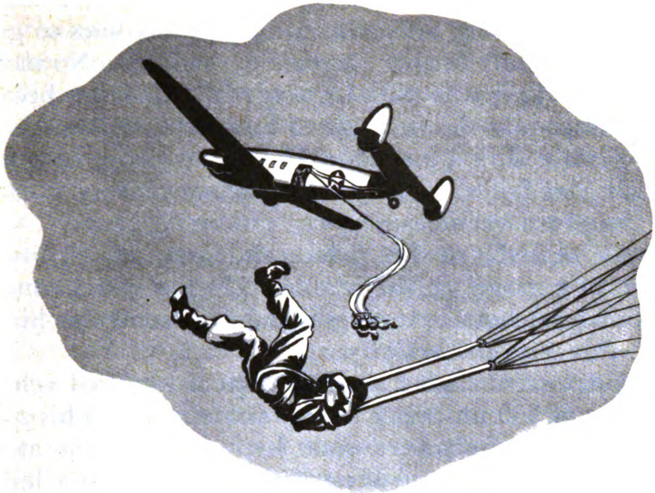
7. (*a*) Mention a few parachutes that were developed during World War 1.
   (*b*) What was the maximum speed at which these parachutes could be used safely?

8. The first free-type parachute was developed in
   - *a.* 1919.
   - *b.* 1922.
   - *c.* 1924.
   - *d.* 1926.

9. The first emergency use of a free-type parachute was made in
   - *a.* 1919.
   - *b.* 1922.
   - *c.* 1924.
   - *d.* 1926.

10. The first type parachute to be made foolproof was the
    - *a.* Heinecke.
    - *b.* Type S.
    - *c.* Mears.
    - *d.* Guardian Angel.

11. The Type S parachute was adopted for general Army-Navy use in
    - *a.* 1919.
    - *b.* 1922.
    - *c.* 1924.
    - *d.* 1926.



CHAPTER 2

"HIT THE SILK"

THE ATMOSPHERE

In order to construct, service, and operate a parachute for foolproof performance, you must understand something about the atmosphere and how it affects the performance of a parachute.

Air tends to resist any object that passes through it. If you dive off a high springboard, you can feel that resistance, and if you've tried walking against a high wind, you know it's there. The faster an object moves through the air, the greater the resistance it has to meet. This resistance slows down the speed of the moving body.

A man permitted to fall freely through the air will, at the end of one second, have fallen 16 feet and will be falling at a velocity of 32 feet per second. At the end of two seconds, he will have fallen 64 feet and his velocity will be 64 feet per second. At the end of three seconds, he will have fallen 144 feet and his velocity will be 96 feet per second. During the next few seconds, his velocity will increase still further. As he reaches these higher velocities, however, air resistance finally becomes so great as to prevent any further increase in velocity. No matter how much farther he falls, he won't fall any faster because the air that piles up in front of him as he falls resists his body surface with a force equal to the tendency of gravity to pull him faster. This final constant velocity is called the TERMINAL VELOCITY.

Down near the earth's surface, the terminal velocity for a man of average weight is about 175 feet per second or 120 miles per hour. It takes about 12 seconds for him to reach this terminal velocity.

During recent high altitude jumps, a terminal velocity in excess of 300 miles per hour was attained. This speed was possible mainly because at high altitudes the atmosphere is so rare that it offers little resistance to a falling body.

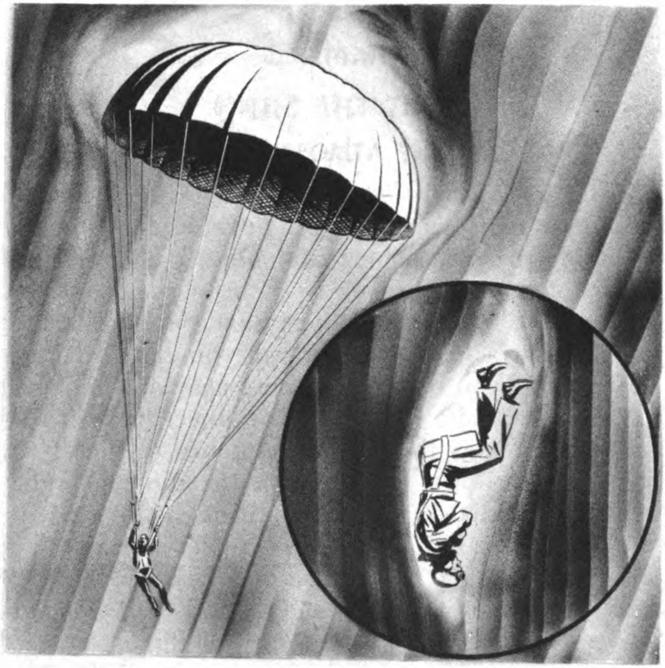


Figure 1. — Comparison of air resistance upon large and small surfaces.

A parachute is designed so that it can take advantage of air resistance. That's how it is able to lower a flier safely to the ground.

The parachute is required to lower a man at a safe rate of descent regardless of conditions. It accomplishes this purpose largely because it is able to present a large "body surface" — 450 square feet — to the air. The total area of a 24-foot (diameter) canopy is 450 square feet. Only about 55 percent of this total area is effective in actual use, since the weight of a body pulls in the edges of the resisting surface, thus making the *projected effective diameter* smaller than the actual diameter.

The surface of a parachute is arranged in a form that takes maximum advantage of resistance. The air resistance of a hemispherical shape (that of a parachute) is about 12 percent greater than that of a flat surface of the same diameter.

Figure 1 illustrates the manner in which air resists a body falling without a parachute, and also how air resists a parachute. Notice that the air currents are practically undisturbed by the falling man, while the parachute's greater "body surface" considerably affects the air currents. This illustration demonstrates the increased resistance afforded by the parachute.

Such resistance is extremely effective. The opened parachute almost instantly retards the rate of descent to a terminal speed of approximately 19 feet per second, the amount of check depending upon the diameter of the canopy, weight of the jumper, and atmospheric conditions.

If a body were to fall from an airplane traveling in a vacuum at 100 m. p. h., it would continue forward at the speed of the airplane, or at 100 m. p. h. However, in the atmosphere, a jumper from a fast-moving plane will fall in two directions — downward and forward.

BRAKES

Taking advantage of maximum air resistance suddenly exerted in the midst of a hurtling plunge requires a *strong* parachute. The greatest strain occurs at the moment the chute opens, and the total force acting on a parachute at this instant depends on the speed of the plane from which its wearer jumped, his weight, the distance fallen before the chute was called upon, and the altitude.

The parachutist jumping from a plane traveling at 100 m. p. h. and opening his chute almost immediately, subjects the parachute to a strain of approximately 2000 pounds. The parachute, however, has been prepared for even greater strain. Parachutes in current use are designed and constructed to withstand a maximum strain or SHOCK LOAD of approximately 40 G's (40 times the force of gravity).

It appears doubtful that a human being can withstand a shock load greater than 23 or 24 G's without reasonable support, and then only if sustained for a relatively short time (less than one second). A man receiving a 10 G opening shock absorbs a force ten times his weight in pounds. Therefore, at 100 m. p. h., a man weighing 200 pounds and experiencing an opening shock of 2000 pounds, has been subjected to a 10 G opening force. The number of G's equals the opening shock or force divided by the weight of the man jumping.

THE VERTICAL VELOCITY IN FEET PER SECOND OF A FULLY OPENED PARACHUTE IS KNOWN AS THE RATE OF DESCENT.

LIGHT AIR

At sea level, we take in about one pint of air with each breath. Air at sea level is dense, and composed of about one-fifth oxygen. At 18,000 feet, the air is lighter, and for each pint of air at that altitude, only one-half the amount of oxygen is present. This is not enough for human needs. Therefore, at altitudes greater than 15,000 feet, pilots, crew, and parachutists alike, require oxygen equipment.

COLD AIR

The higher the altitude, the lower the temperature. At 36,000 feet, the temperature drops to 60 degrees F. BELOW ZERO.

Parachutes carried in planes at these high altitudes are seriously effected by these sub-zero temperatures. When subjected to severe low temperatures, it has been found that pack-opening elastics become stiff. One-type of chute designed for low temperatures has proven quite successful in that it eliminates the use of pack-opening elastic. In this type, the opening of the pack is accomplished by the pull of the rip cord and the action of a pilot chute.

Another hazard to consider at great altitudes is the freezing of excessive moisture on parachute canopies — the numerous pleats and folds actually become encased in ice. This condition is also highly injurious to the parachute fabric. Certain late types of aircraft capable of ascending to great heights are equipped with pressurized cabins, thus reducing considerably the danger of frozen pack-opening elastics or canopies.

NEW HORIZONS

The conquest of the upper regions has only begun. The stratosphere beckons, and jet propulsion planes hint at ever greater triumphs in conquering the atmospheric forces.

Let's consider several parachute problems currently confronting aviation.

A pilot bailing out at 50,000 feet faces a number of serious difficulties. First of all, he will lack adequate oxygen if he depends on existing oxygen equipment, and secondly, the radical drop in temperature from the warmth of a cockpit would probably prove fatal.

Third, an airplane, to stay aloft in thin air, must travel at an enormous rate of speed, and the sudden blast of wind striking a parachutist would undoubtedly overcome him. He might also strike the tail fin unless he were projected high from the cockpit.

Basing our judgment on these factors, it appears that the solution may lie in an air-tight enclosure, or capsule, in which the parachutist may escape from the plane and from which he may emerge later for the final descent. It is evident that a great deal of emphasis must be placed

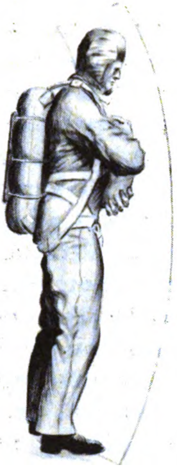


Figure 2. — Parachutist ready for the jump.

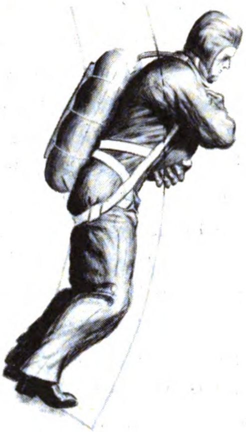


Figure 3. — Body forward, knees bent.

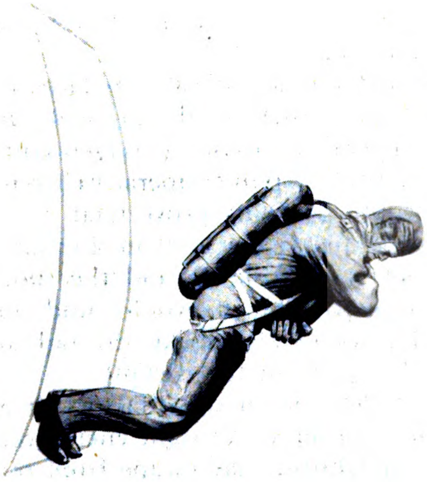


Figure 4. — Ready to spring into a dive.

on parachute improvement with regard to the method of solution. Existing chutes cannot withstand the strain of opening at terrific speeds. When such improvement is effected, an accompanying development must take place to prevent too sudden a check on the rate of descent of the parachutist as a result of the opening shock. A great deal of work lies ahead.

THE PARACHUTE JUMP

In figure 2, a parachutist is shown ready to jump. As he leans forward, knees bent, as shown in figure 3, he pushes himself as though he were about to spring into a dive, as illustrated in figure 4.

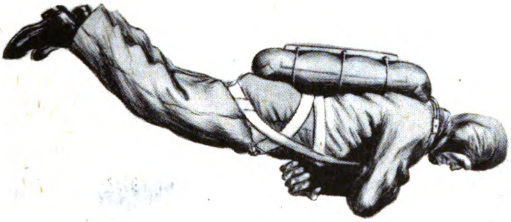


Figure 5. — First stage of the jump.

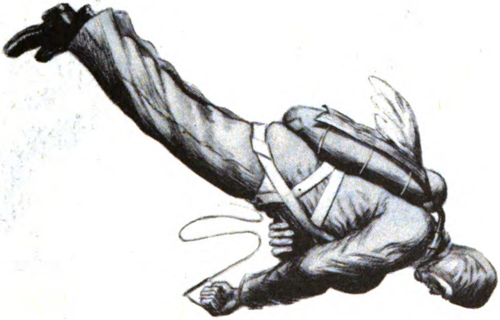


Figure 6. — Falling head foremost.

As the jumper leaves the plane, he is practically in a prone position, as shown in figure 5. As may be seen in figure 6, the heavy part of his body pulls him head foremost. We have learned that the air is resisting his body surface as he falls. He has not yet had time to reach his terminal velocity, but he pulls the rip cord to open his chute, and a small chute — the PILOT CHUTE — pulls the parachute from the pack on his back (see figure 7).

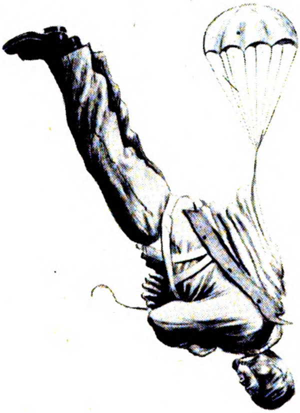


Figure 7. — Pilot chute deploying from pack.

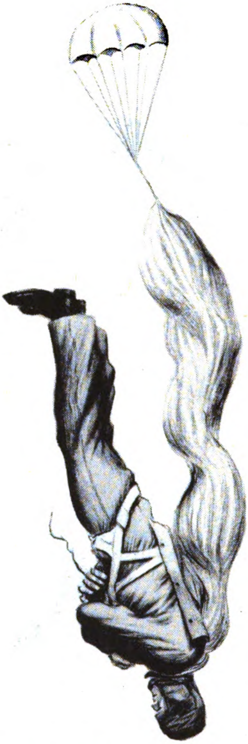


Figure 8. — Still going down.

Still practically upside down, as shown in figure 8, the parachutist continues his downward plunge.

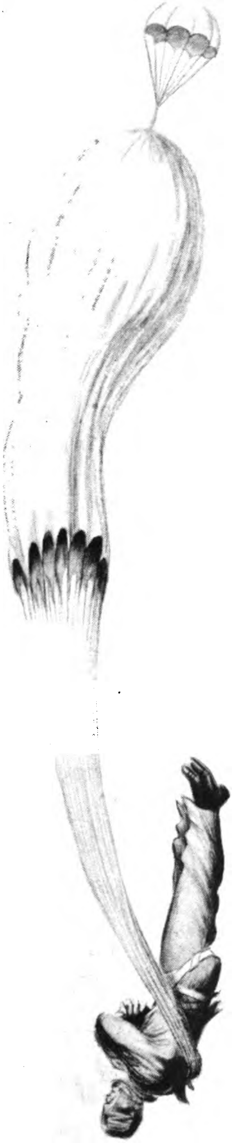


Figure 9. — Parachute free of pack.

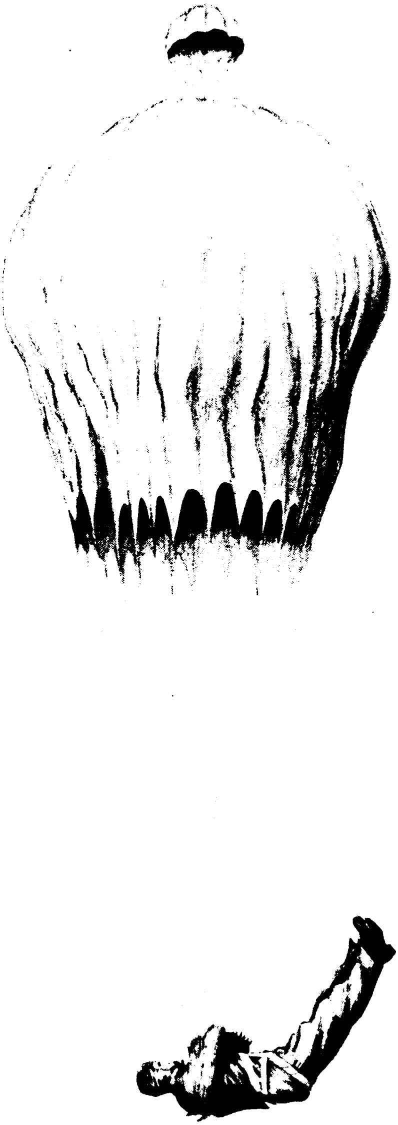


Figure 10. — Maximum body surface of canopy not fully presented.

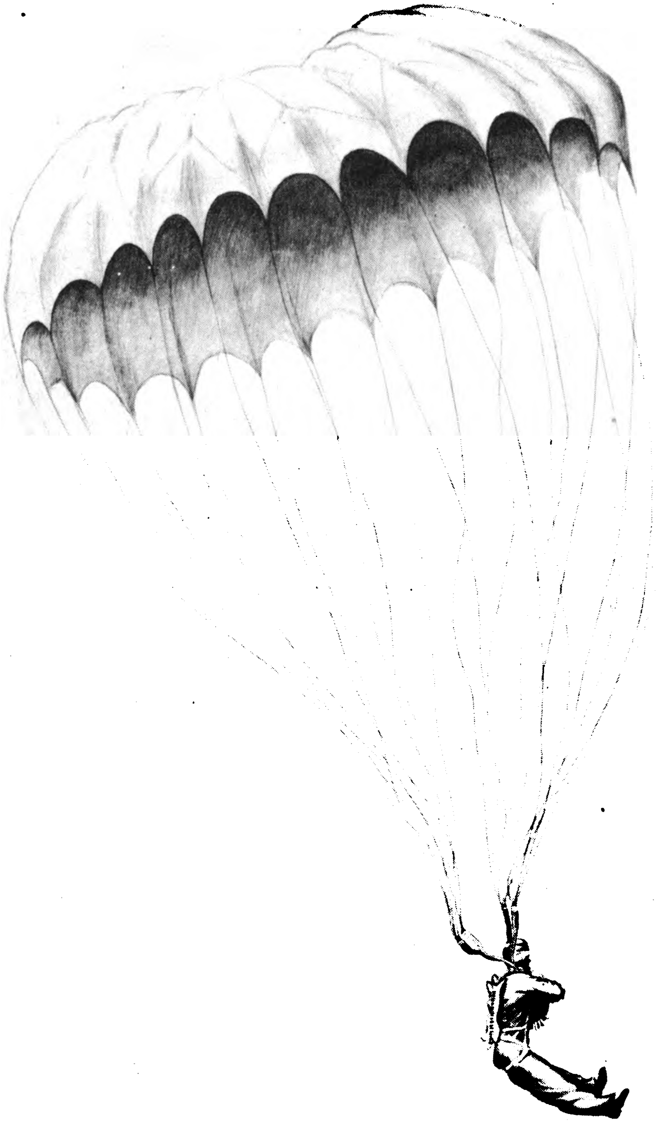


Figure 11. — Maximum body surface of canopy presented.

Before proceeding further, it must be understood that the positions described and illustrated are not the same each time a jump is made. Positions during the jump depend upon the start of the jump itself; for example, an uneven push or thrust by one of the jumper's legs will cause him to twist abruptly.

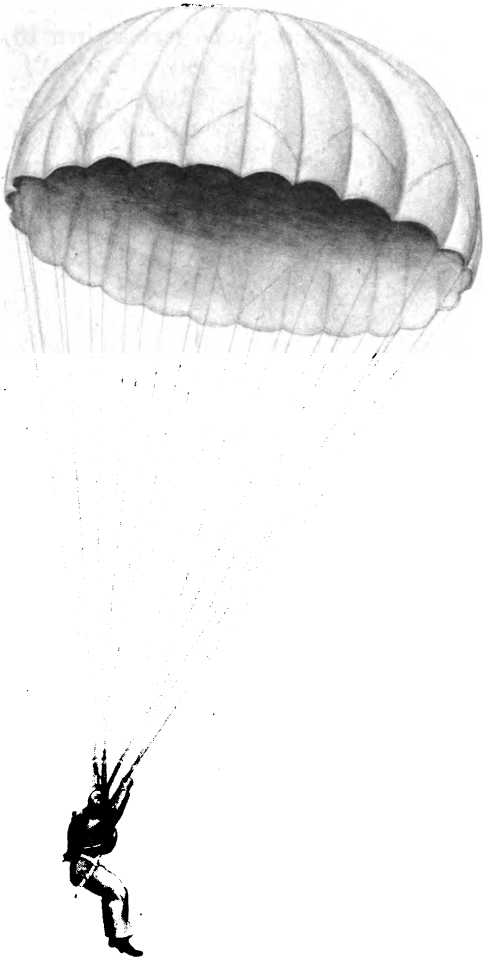


Figure 12. — Harness adjustment for comfort.

We have reached the stage in our discussion of the jump where the parachute is about to take over. In figure 9, the chute may be seen completely free of the pack, and the jumper appears to be starting the second half of his somersault.

The canopy has not yet, however, presented its maximum surface to the atmosphere (see figure 10).

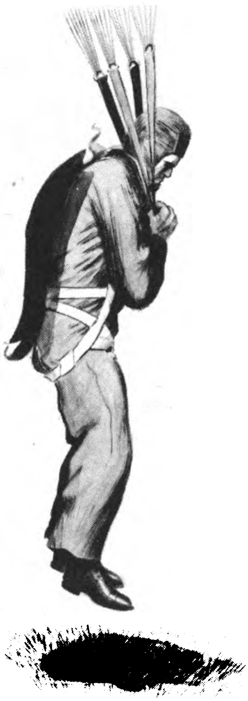


Figure 13. — Landing position.

When the air fills the inverted cup, it resists the canopy, and THE BRAKES ARE APPLIED WITH FORCE. At this moment, the canopy presents its maximum surface (see figure 11).

The opening time — from the instant the rip cord is pulled until the canopy is fully spread — takes less then two seconds for the current service parachute. It may be seen that the parachutist absorbs most of the shock while in a sitting position. Notice that the pilot chute has disappeared. The air immediately below the pilot chute is cut off to a great extent by the main canopy, and with no air resistance, the pilot chute quickly collapses to dangle alongside the main canopy for the balance of the descent.

By adjusting his position in the harness, as illustrated in figure 12, the jumper may even assure himself a fairly enjoyable ride to earth.

As the jumper prepares to land, he bends his knees and takes a firm grip on the lift webs. His chute may encounter resistance even on land if it is not collapsed as soon as the descent is accomplished.

QUIZ

1. A freely falling body will fall 16 feet during the first second. At the end of two seconds, it will have fallen
   a. 32 ft.
   b. 48 ft.
   c. 64 ft.
   d. 144 ft.

2. At the end of one second a freely falling body will have a velocity of 32 feet per second. At the end of two seconds its velocity will be
   a. 32 feet per second.
   b. 48 feet per second.
   c. 64 feet per second.
   d. 96 feet per second.

3. That velocity or speed at which the accelerating pull of gravity is balanced by air resistance so that the tendency of an object to fall faster and faster is overcome, is called
   a. terminal velocity.
   b. maximum velocity.
   c. final velocity.
   d. balanced velocity.

4. Why are parachutes designed in inverted cup shapes?
5. At what point in the jumper's descent is the greatest strain put on his parachute?
6. What are some of the difficulties that would face a pilot bailing out at 50,000 feet?

CHAPTER 3

TYPES OF PARACHUTES

FREE FALL

The modern service parachute is carried as a complete unit and is strapped to the jumper. All service chutes are FREE FALL, MANUALLY-OPERATED units, there being no static line attachment to the aircraft.

The great majority of parachutes serviced by Parachute Riggers are variations of the free fall chute. The Navy uses comparatively few of the ATTACHED TYPE, which is limited to training and cargo service.

Paratroopers are usually so weighted with equipment that the shock load following the opening of a chute after a long fall might black them out temporarily. After jumping, they have only seconds before going into battle. They CAN'T be just getting over the effects of a black-out. To make sure that they encounter a minimum shock load, paratroopers use STATIC LINES almost entirely. One end of the static line is attached to the parachute; the other has a hook on it. When the jumper is ready to leave the plane, he simply hooks the line onto a cable within the plane. When he jumps, he falls the length of the static line. When he reaches that point, the hooked end within the plane remains firm. As the rip cord is pulled, a small cord between the rip cord and the canopy is broken, and the parachute falls free.

In emergency jumping, it is imperative that the disabled aircraft be cleared before the parachute rip cord is pulled. With the free fall chute, a jumper may pull immediately after clearing the plane or he may prolong his fall, depending upon circumstances. Low altitudes require the jumper to pull almost immediately, while from greater heights a jumper has opportunity to make a DELAYED RELEASE jump. This maneuver may aid the parachutist to avoid enemy gunfire both from the ground and from the air, as well as retarding his descent from a high to a moderate speed due to "air resistance," thus assuring an easier opening shock.

Yet another factor must be considered in the long free-fall jump. At the time of bail-out, the plane may be at 30,000 feet, and the jumper may not have portable oxygen gear. In this case, the jumper simply inhales deeply before letting go, and falls to a safe altitude before opening the chute. Experienced jumpers describe this sensation as "lying on a feather bed," and advise against panic whenever a long free fall is necessary.

Variations in the construction of the free fall parachute permit variations in the type of service a parachute will render. There are at present numerous models of service chutes, but regardless of all differences, the canopy design remains essentially the same.

Two standard size service canopies exist, each of which may be used alternately with any parachute design listed. The controlling factors of design and construction lie in the ever-changing design of aircraft and the surroundings in which such craft operate. Standard Navy parachutes are listed in Table I, page 23.

A number of the QAS (quick-attachable seat) type of parachutes still remain in service. These are listed under revision No. 15 of the Naval Aircraft Factory standard drawings — 1055, sheet numbers 4 and 8. The QAS type chute is being replaced by the Quick-fit seat, and in time will be replaced entirely.

TABLE I

Type	*Description*	*Flat diameter of canopy in feet*	*Pack*
SS	Standard Seat	24 or 28	SS
QFS	Quick-fit Seat	24 or 28	SS
QAC	Standard Quick-attachable Chest	24 or 28	QAC
QFAC	Quick-fit Attachable Chest	24 or 28	QAC
SB	Standard Back	24	SB
QFB	Quick-fit Back	24	SB
T	Training Assembly (TR and TB)	TR — 24	TB and QAC
T		TB — 28	

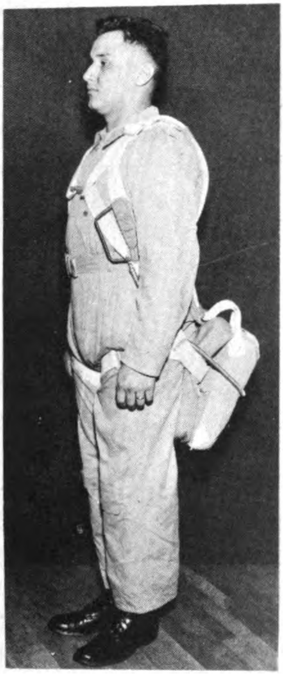


Figure 14. — Standard seat and regular harness.

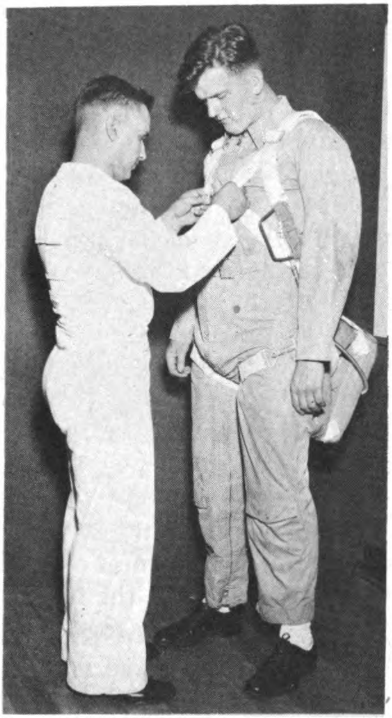


Figure 15. — Standard seat and oversize harness.

STANDARD SEAT

The SS is a Navy Standard parachute (USE-SERVICE) used by pilots and other personnel whose duties aloft restrict them to a seat. This parachute may be rigged with or without the pararaft, and is also adaptable to the standard regular and oversize harness as well as to the quick-fit harness.

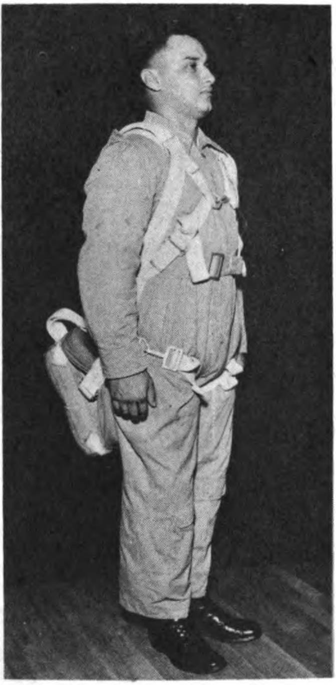


Figure 16. — Standard seat and quick-fit harness.

When used with the 24-foot canopy, the regular standard size or quick-fit harness may be employed. When the 28-foot canopy is used, the standard design (oversize harness) or quick-fit harness, together with a slightly larger pack, may be utilized.

Figures 14, 15, and 16 illustrate the various seat-type units currently worn by flight personnel.

QUICK-ATTACHABLE CHEST

The QAC USE-SERVICE type of parachute is used mainly by aerial gunners, observers, and mechanics, in all types of aircraft in which crews must move actively about. The

QAC is used almost exclusively in large patrol planes, and is the most popular chute in Naval Aviation, since only the harness is required to be worn while in flight, the parachute being stowed in a convenient location in the plane.

This particular design permits absolute freedom of movement to the wearer, who is able to crawl about in restricted areas without the danger of "cracking" his chute.

For the ultimate in safety and accessibility, the entire parachute assembly — harness and pack — should be worn at all times.

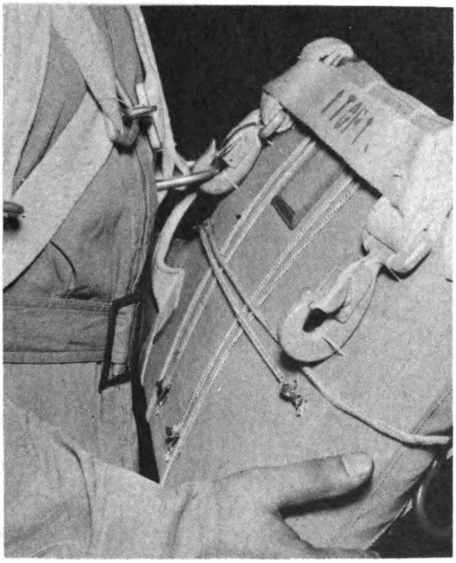


Figure 17. — Proper manner of engaging the QAC pack to harness.

If the harness is worn properly adjusted, the QAC may be quickly engaged to the pack if bailing out becomes necessary. To accomplish this step, the pack should be gripped so that the hand pull is in front and to the right. Then, with a quick UPWARD stroke, first one and then the other snap is engaged in the D-shaped quick-connector links of the harness. The pack thus connected is ready for the jump. Figure 17 illustrates the manner in which the pack is snapped to the harness.

A QAC chute may be rigged with or without the para-raft. A regular or oversize harness may be used, respectively, with 24-foot and 28-foot (diameter) canopies, or with the new quick-fit harness. Figures 18, 19, and 20 show the QAC parachute rigged with the different harnesses.

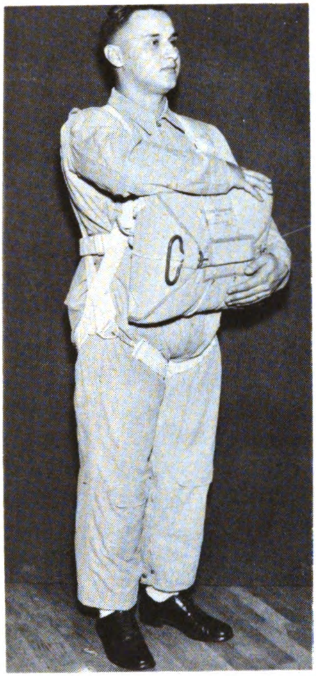


Figure 18. — QAC parachute and regular harness.

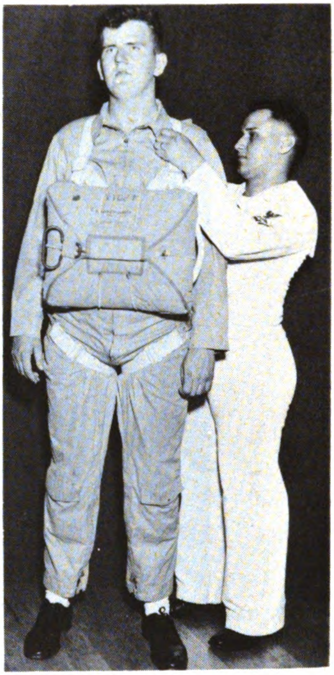


Figure 19. — QAC parachute and oversize harness.

STANDARD BACK

The SB USE-SERVICE parachute is a STANDARD-BACK unit, worn on the back, and employing a long, narrow, thin pack. It is primarily designed for the comfort of the wearer. Airmen equipped with this chute are permitted greater freedom of movement than with any other design excepting the QAC.

In some instances, the SB parachute has met with success in replacing the SS and pararaft combination units. Where the SS and pararaft combination tends to seat the pilot too high in the cockpit, the standard back chute has the opposite effect.

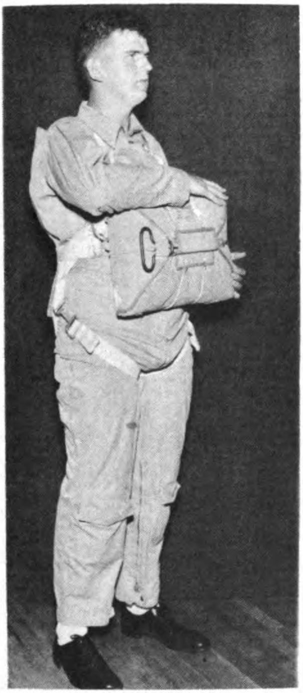


Figure 20. — QAC parachute and quick-fit harness.

In figure 21, the SB chute is demonstrated with the standard regular harness and without the pararaft, and figure 22 affords a study of the same parachute attached to a quick-fit harness and a pararaft.

QUICK-ATTACHABLE SEAT

The QAS USE-SERVICE parachute is a slightly variated model of the standard seat unit. Instead of being a "fixed" type, it is constructed as a "quick-attachable" chute, as the name implies.

Hook-up of the QAS pack and harness may be accomplished by connecting the two riser quick-connector snaps to the D-shaped quick-connector links of the lift web assembly.

The adoption of the quick-fit harness will probably result in a decline in the use of the QAS parachute.

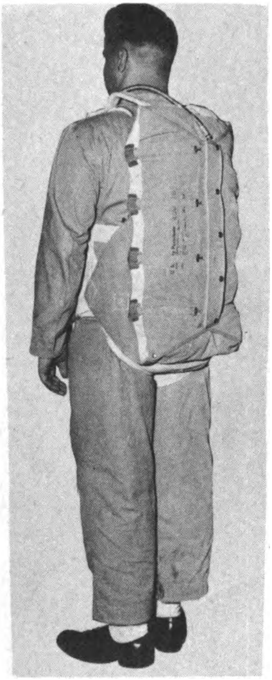


Figure 21. — SB parachute rigged with regular harness and without pararaft.

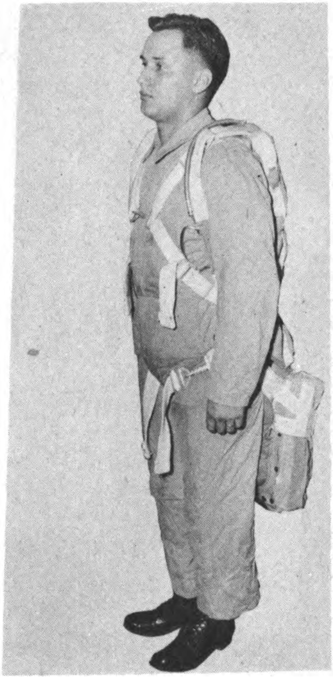


Figure 22. — SB parachute rigged with quick-fit harness and pararaft.

TRAINING OUTFIT

The TB AND TR USE-TRAINER parachutes are training-type chutes the use of which is compulsory for PREMEDITATED LIVE JUMPS.

As may be seen in figure 23, this outfit has TWO COMPLETE PACKS. One is called a TRAINING BACK, while the other and smaller parachute serves as a TRAINING RESERVE.

The TB, being the mainstay of the training rig, carries a 28-foot canopy which affords slower and safer rates of descent. The TR contains a 24-foot canopy which is ready for emergency use.

The TR parachute, which is carried in front of the harness, is nothing more than a QAC. With a few changes, the QAC becomes a TR, sometimes called a training chest, or TC. By removing the pilot chute, adding a belly-strap, and packing the parachute in such a manner that the quick-connector snaps lie back so that the pack can be engaged with a downward stroke, the QAC may very quickly be transformed into a TR.

STATIC LINE

The training outfit may be rigged for a static-line jump as readily as for a free fall. When rigged for a STATIC-LINE JUMP, the chute will operate mechanically by means of a static line, which is merely a long section of webbing with one end fitted with snap hardware while the other end terminates in a STATIC-LINE RIP CORD.

Preparing to jump, the parachutist hooks the snap end to a stationary cable secured in the plane. The other end of the line is holding the parachute closed by means of the static-line rip cord. When the chutist has jumped and has fallen the length of the static line, the parachute opens. A "break tie" located between the static line and the peak of the canopy, sufficiently strong to pull the canopy and shrouds out of the pack, breaks at the proper moment to free the parachute and the jumper.

Although the static line affords ample leeway in clearing the aircraft, it can be neither too long nor too short. If the line is too long it may foul the tail section of the airplane; if too short, the parachute would open too near the exit of the plane and possibly result in the canopy fouling on the tail section of the aircraft.

CARGO CHUTES

An AERIAL DELIVERY parachute is used to drop loads of supplies and equipment. It is a means of delivering cargo from the air. The Army type G-1 aerial delivery parachute is used in conjunction with various containers, cartons, packs, slings, nets, and similar types of packages, especially designed for handling and enclosing supplies and equipment generally delivered by air.

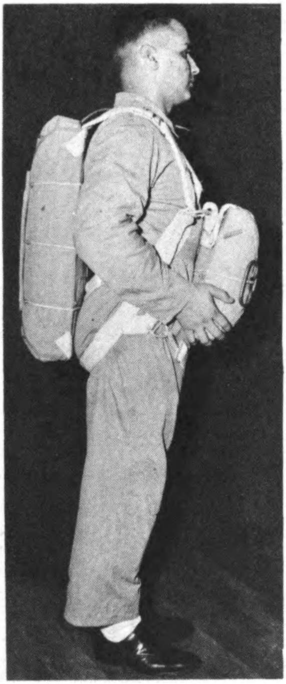


Figure 23. — Training outfit rigged for a premeditated free fall jump.

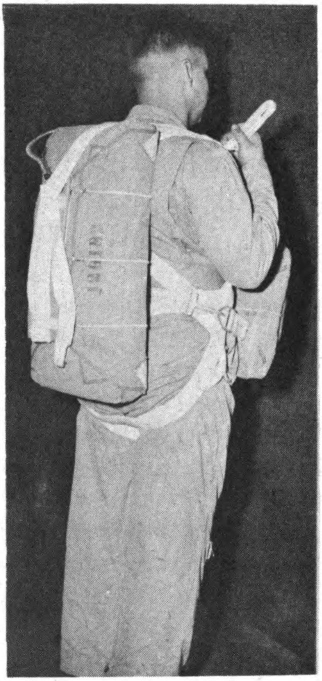


Figure 24. — Training outfit rigged with static line.

A static line is used for all cargo drops. Figure 25 illustrates a type of cargo chute, that may be used for dropping cargo up to 300 pounds in weight.

The parachute canopy is not visible in figure 25 as it is concealed by the "drum"-shaped pack. Man-carrying parachutes which have been surveyed make excellent cargo chutes, and may be utilized whenever the standard Army G-1 aerial delivery unit is not available. The cargo chute shown in figure 25 was manufactured without the aid of drawings, and is representative of the types of chutes every Parachute Rigger may be called upon to devise at any time.

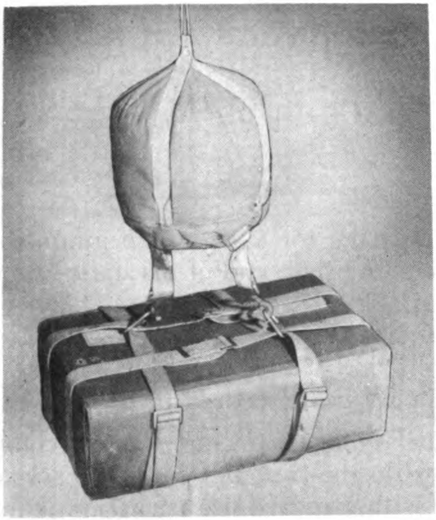


Figure 25. — Cargo chute with improvised pack and lift web assembly and surveyed 24-foot canopy.

QUIZ

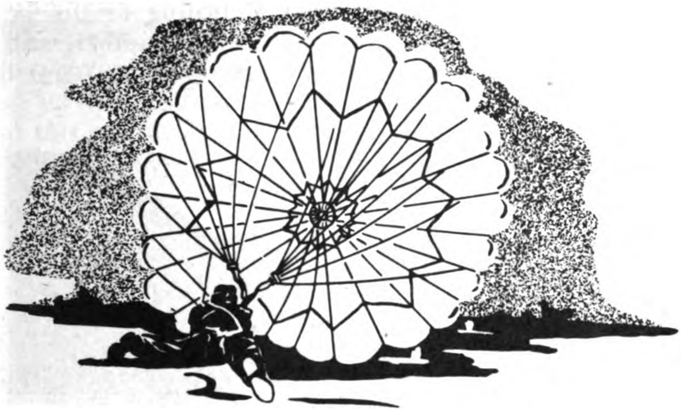
1. What is a "free-fall" parachute?
2. If a person bails-out of a plane at 30,000 feet and is not equipped with portable oxygen gear, he should open his chute when
   - *a.* he leaves the plane.
   - *b.* he reaches a safe altitude.
   - *c.* he reaches his terminal velocity.
   - *d.* his breathing becomes difficult.
3. The QAS type of parachute
   - *a.* is no longer used by the Navy.
   - *b.* is being replaced by the QFS type of chute.
   - *c.* is replacing the QFS type parachute.
   - *d.* is the newest type parachute.

4. The type of parachute which is used almost exclusively in large patrol planes is the
   - *a.* SS.
   - *b.* QFS.
   - *c.* QFAC.
   - *d.* QAC.

5. The parachute which is used for premediated live jumps is the
   - *a.* SS.
   - *b.* QAC.
   - *c.* SB.
   - *d.* TB and TR.

6. When preparing for a static-line jump, the parachutist hooks the snap end of his static-line to
   - *a.* the static-line rip cord.
   - *b.* the left side of the parachute harness.
   - *c.* the right side of the parachute harness.
   - *d.* a stationary cable secured in the plane.

7. (*a*) Which type of parachute has two complete packs?
   (*b*) How do the canopies of these packs compare in size with standard-size packs?



CHAPTER 4

PARACHUTE CLOSE-UP

PARACHUTE DESIGN

Parachutes are masterpieces of design and construction, with maximum strength the primary requirement.

The five major parts of a parachute — PILOT CHUTE, CANOPY, SHROUD LINES, PACK, and HARNESS — are shown in figure 26. Each part is designed to perform a definite task, and each part is carefully constructed so that possibility of failure is almost entirely eliminated.

To keep a parachute in perfect working condition, you will service and repair these parts. The proper performance of such work requires a thorough understanding of each component.

PILOT CHUTE

The function of the PILOT CHUTE is to hasten the opening of the main canopy by pulling it from the pack faster than it would emerge of its own accord. The pilot chute also serves to prevent fouling of the main canopy about the wearer's body.

Figure 27 demonstrates a plan view of a typical pilot chute. Several models of pilot chutes are in service use;

the one shown is manufactured according to the latest Naval Aircraft Factory or AN drawing number, and is used with 24-foot and 28-foot QAC, QAS, SS, and TB canopies.

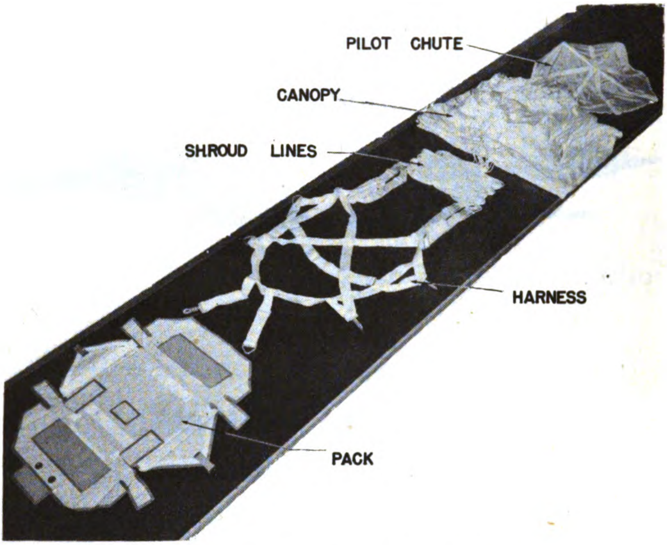


Figure 26. — Five major parts of a parachute.

The pilot chute canopy (A) consists of one piece of fabric (silk or nylon) one yard square and cut in the pattern of a polygon of eight sides. Four lengths of one-inch cotton reinforcing tape (B) are sewed criss-cross to the inner surface of the canopy. It will be noted that the pilot chute frame (C), constructed of metal ribs (D) and springs (E), is secured to the canopy by means of short cotton tape rib pockets (F) in such a manner as to force the pilot chute open when it is released from the pack. The four rib pockets are sewn 90 degrees apart to the one-inch criss-cross tape. Four type-1 shroud lines (G), 60 inches long, are sewed to the canopy two inches up the skirt by zigzag stitching (H). An attachment point or loop (I) is constructed in the shroud line by either a cord-serving or the alternate zigzag sewing for the purpose of securing the pilot chute to the connector cord (J). The pilot chute connector cord is merely two inches of Type III shroud line 42 inches long and sewn zigzag together to form a double line. Each end is dipped into a mixture of beeswax and paraffin to prevent fraying. The purpose of this cord is to secure the pilot chute to the peak of the main canopy.

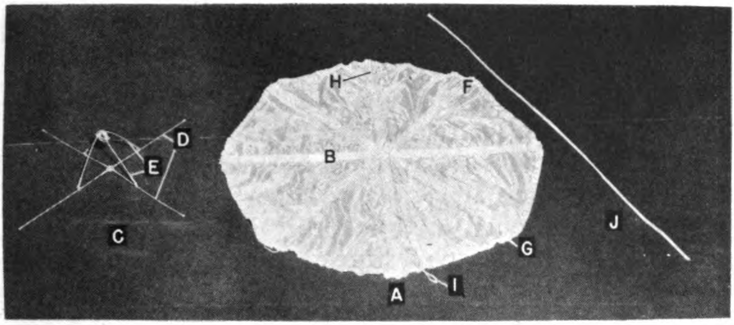


Figure 27.— Pilot chute canopy, frame, and connector cord.

CANOPY

It has been established that the purpose of the parachute is to brake the fall of the jumper or descending object, and we have also seen that the CANOPY is designed to absorb the moment of strain without faltering. Just as with any other type of brake, the parachute must meet a force evenly. This fact explains the necessity for care and precision in canopy construction.

Figures 28 and 29 present two views of the 24-foot standard parachute canopy. The 24 GORES shown require about 65 yards of fabric to form a canopy. Each gore is constructed in four panels, is triangular in shape, and is joined to adjacent gores along the edges by radial seams. These seams are double-lapped, with four rows of stitching extending from the skirt to the vent.

Silk and nylon sewing is done with Types E and B thread. Silk thread is used to manufacture and repair silk cloth, while nylon thread is used exclusively in nylon cloth. The two threads must not be mixed, as the elasticity of silk and nylon is unequal.

Each gore is composed of four panels of different sizes, as follows:

TABLE II

24-FOOT STANDARD CANOPY

Panels	*Size*
A	6⅞ net square feet
B	9⅞ net square feet
C	5½ net square feet
D	⅞ net square feet

Each panel is cut on a bias, i.e., diagonally. The SELVAGE EDGE or finished edges are so planned in the fabric cutting as to comprise, as much as possible, the diagonal seams. All panels are joined together to form a gore, diagonal seams being used for this purpose. DIAGONAL SEAMS are double-lap type stitched with two rows of Type B silk or nylon thread. All other canopy sewing is done with Type E thread.

Notice particularly the manner in which the gores and sections are assembled. The cloth is so cut and arranged in the canopy that the warp and filling threads are placed at an angle of 45 degrees to the center line of the gores. This is known as BIAS CONSTRUCTION and is largely responsible for distributing the strain over the fabric at the moment of greatest stress. It also partially prevents tears from continuing up or down the entire gore.

The SHROUD LINES are inserted into the pockets formed by the two inner rows of stitching along the radial seams of the finished canopy. At the periphery, or skirt, the lines are reinforced with short lengths of Type-I webbing.

The skirt hem is reinforced with surgeon's tape; the vent is strengthened with a comparatively bulky one-inch-wide tubular nylon webbing more than three times as strong as the skirt reinforcement. The purpose of the tape and webbing is to hold the fabric body together in case a gore should split from skirt to vent.

The opening at the apex, or top, of the canopy is the VENT. This aperture is made 18 inches in diameter with the shroud lines extending across, 17 inches in length. Encircling the vent on the upper side of the parachute is a fabric cylinder forming a chimney-like projection approximately eight inches in height. This projection is the VENT COLLAR. At the upper or free end of the vent collar is a hem in which is placed a rubber ring, the VENT CLOSING ELASTIC.

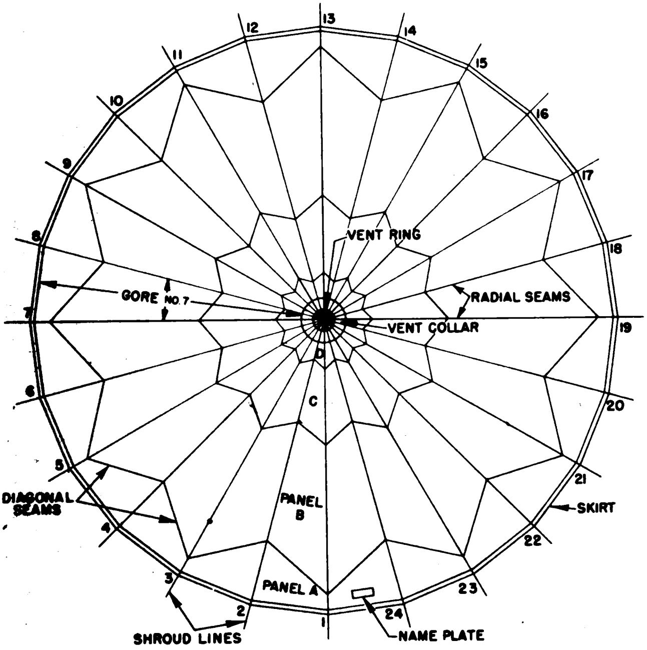


Figure 28. — Standard 24-foot canopy, a perfect polygon of 24 sides.

The vent acts as a SAFETY VALVE and aids in relieving high internal pressure within the inverted cup-shaped parachute at the moment of opening, thus preventing air from being trapped in the inflated canopy. Air thus trapped would result in uneven pressure, and the chute would descend in an excessive pendulum-like swing or OSCILLATION. The air pressure which is not relieved by the vent, spills out the sides and creates a certain amount of oscillation, despite the vent. Without a vent, high-speed parachute openings would result in severe rupture of the canopy unless the internal pressure was relieved.

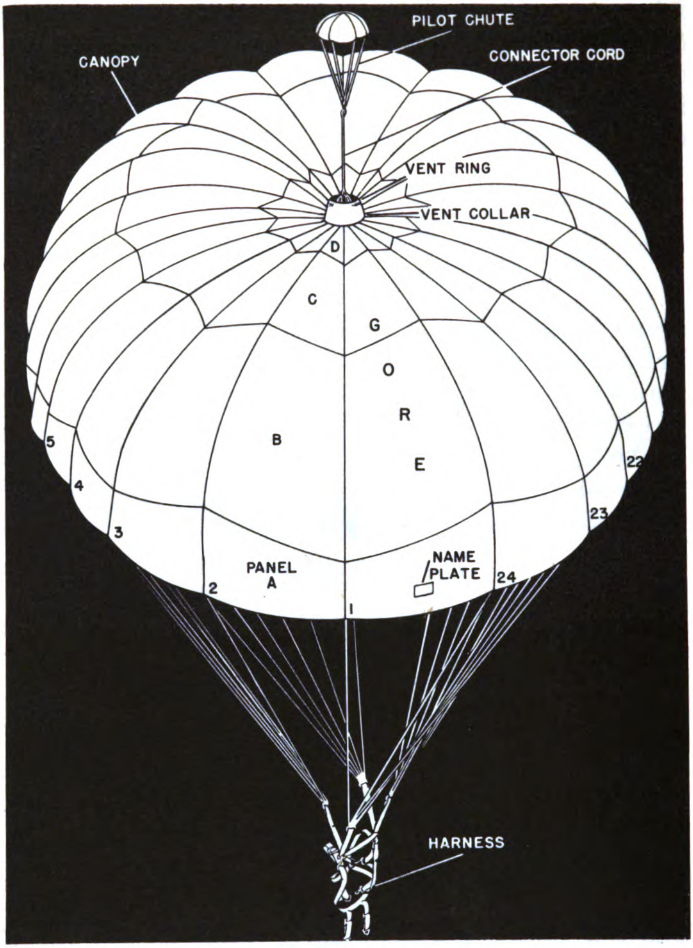


Figure 29. — 24-foot canopy.

In many cases, the canopy would collapse because of excessive air spillage.

The vent-closing elastic permits full expansion of the opening at the top of the vent collar during the period of high pressure. When the parachute reaches its normal rate of descent, the closing elastic contracts the vent to a smaller diameter. Therefore, the vent is capable of stretching to many times its normal diameter.

Each canopy manufactured for the Navy is stamped with the maker's name-plate on the upper side of panel A between shroud lines number one and 24, and each gore is stamped with either the letters AN or the Navy's official stamp. The final striking date and serial number is also marked in two or more places on the canopy. Stenciling ink used for such marking is manufactured to specifications designed to prevent damage to the cloth.

BIAS CONSTRUCTION, it may be pointed out, is not the only type of canopy manufacture. A popular commercially used "straight construction" method is also in vogue. In this method the cloth is cut parallel to the warp and filler threads rather than on a bias. There are no small sections where straight construction is employed, as the gore is made from a single piece of cloth. The Navy is experimenting with straight construction employing "Rip Stop" nylon and other uniquely woven fabrics.

SHROUD LINES

The SHROUD LINES form a net or skeleton for the canopy, and for this reason absorb a great portion of the shock load. They also act as connecting supporters between the canopy and lift webs.

A set of shroud lines for each 24-foot canopy consists of 12 lengths of braided line, Type III silk, or nylon, depending upon the material used in the main canopy. Each length of line measures 65 feet and seven inches under specified tensions, and each line is continuous and free of knots or splices. The lines run from the connector link of one harness lift web to the skirt of the canopy, up and over the canopy, and thence down to another connecting link on an opposite lift web. There are a total of 24 points of shroud line connections.

All lines must be equal in length to prevent the shock load from centering on individual lines. Therefore, before lines are threaded and sewn into the canopy, a COMPLETE SET of lines is stretched to a specific tension (varying with different materials), marked, and cut.

Figure 30 illustrates the proper method of securing a shroud line where it enters the skirt of the canopy.

Shroud lines are manufactured to current specifications, and have a number of inner cords colored in order to distinguish the maker.

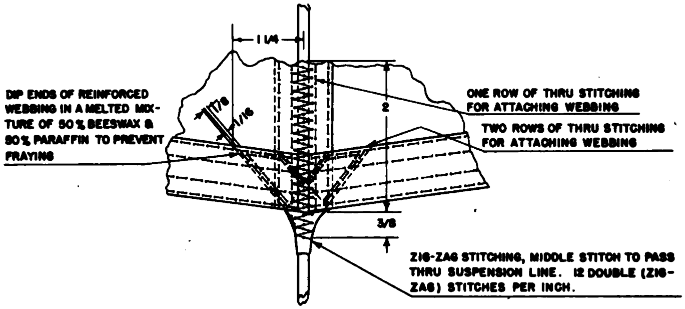

1 1/4
DIP ENDS OF REINFORCED WEBBING IN A MELTED MIXTURE OF 50% BEESWAX & 50% PARAFFIN TO PREVENT FRAYING
1 7/8
1/16
2
ONE ROW OF THRU STITCHING FOR ATTACHING WEBBING
TWO ROWS OF THRU STITCHING FOR ATTACHING WEBBING
3/8
ZIG-ZAG STITCHING, MIDDLE STITCH TO PASS THRU SUSPENSION LINE. 12 DOUBLE (ZIG-ZAG) STITCHES PER INCH.

Figure 30. — Proper method of securing shroud line to canopy skirt.

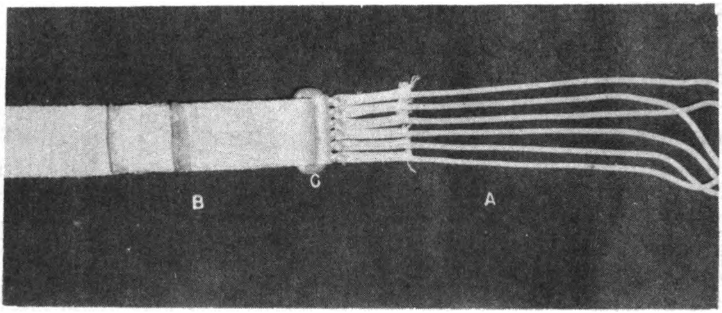


Figure 31. — Shroud lines and lift web secured by means of a connector link.

To prevent the canopy from slipping along the shroud lines, each line is anchored by zigzag stitching at several points to the radial seams through which it passes. One-half inch of slack is allowed between the zigzag sewing points to relieve the strain during opening shocks. This is necessary because the shroud line has a greater percentage of elongation than the canopy fabric.

The 24 shroud lines are distributed into four groups of six lines each, and each group of lines is secured to a connector link as shown in figure 31. In turn, each of the four lift webs is passed through its respective link and sewn back on itself as (B) in figure 31 indicates, thus furnishing the connection between the main canopy and harness. Figure 31 shows but one lift web sewing and one group of six lines secured to a connector link (C).

HARNESS

The principal duty of the HARNESS is to form a sling, or swing, in which the wearer may sit without danger of separation from the parachute at the moment of strain.

The parts of a typical quick-attachable harness are shown in figure 32. Here are shown the harness (A) and lift-web assembly (B), the two related assemblies inevitably present in a quick-attachable design.

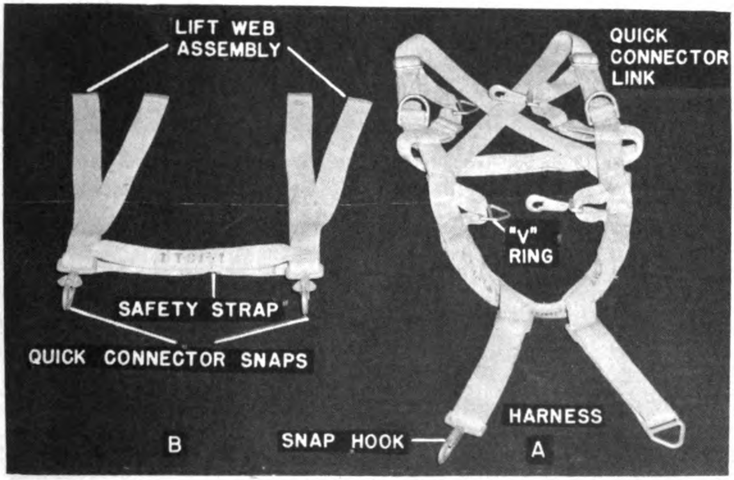


Figure 32. — QAC harness and component parts, including lift web assembly.

The numerous parts of the standard "fixed" type harness are shown in figure 33. Note the manner in which all hook snaps point "in" toward the body.

The illustration shows that in the "fixed" type harness, the lift webs are a permanent running part of the entire unit.

All service type harnesses may be used with either 24-foot or 28-foot canopies, depending upon conditions and circumstances, and provision is made for large men who are physically unable to wear the regular size harness. In each of the following parachute styles, an OVERSIZE HARNESS is available, and should be rigged with the corresponding larger canopy — standard seat, quick-attachable chest, and quick-attachable seat.

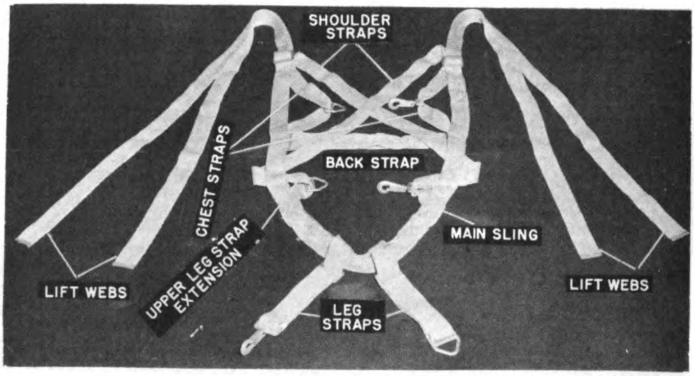


Figure 33. — SS "fixed" type regular harness and component parts.

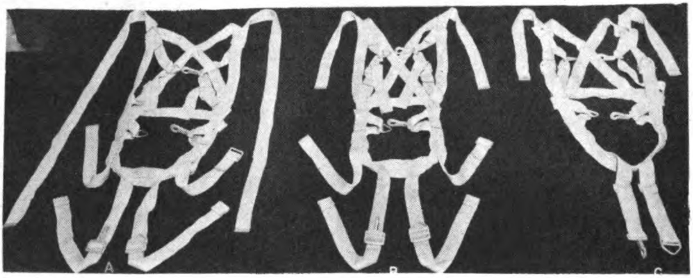


Figure 34. — Standard "fixed" type harness.

The standard seat, standard back, and troop-type harness shown grouped as (A), (B), and (C) in figure 34, are known as "fixed" designs. The corresponding lift webs or risers of these harnesses are permanently sewn to the shroud line connector links.

Figure 35 groups the two QUICK-ATTACHABLE or detachable-type harnesses — the QUICK-ATTACHABLE CHEST and the QUICK-ATTACHABLE SEAT. Notice the SEPARATE LIFT WEB ASSEMBLIES, which are permanently sewn to connector links as in a fixed-type harness. These quick-attachable rigs are fitted with strong attachable hardware which, when engaged, form a safe, strong union. Through simple manipulation of the QUICK-CONNECTOR SNAPS, the separate parachute pack, carrying the lift web assembly, may be attached or detached at will.

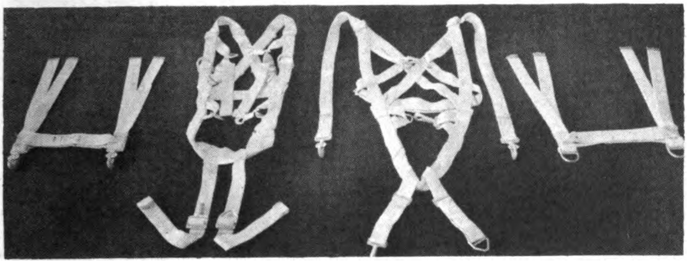


Figure 35. — Quick-attachable type harnesses and lift web assemblies.

All lift web assemblies are fitted with an ingenious SAFETY feature. To provide for instances where but ONE SIDE of the assembly is hooked up, a SAFETY STRAP or yoke is incorporated into the design. This strap prevents the entire unit from failing when only one side of the lift web assembly is attached. Figure 36 illustrates the importance of the safety strap.

Quick connector hardware such as the QUICK-CONNECTOR SNAP and D-SHAPED QUICK-CONNECTOR LINK each have a minimum tensile strength of 5,000 pounds.

The QUICK-FIT HARNESS, adaptable to standard seat, quick-attachable chest, and standard back types of parachutes, is shown in figure 37. This harness differs slightly from other designs. Its main improvement incorporates certain hardware which permits RAPID ADJUSTMENT.

A closeup of the hardware used in the quick-fit chest type harness is shown in figure 38. The units, reading from left to right in the illustration, are the FRICTION ADAPTER, the FRICTION SNAP, and the FRICTION "V" RING.

The easy adjustment of the quick-fit harness makes the construction of several sizes unnecessary. The unit is adaptable to any size desired.

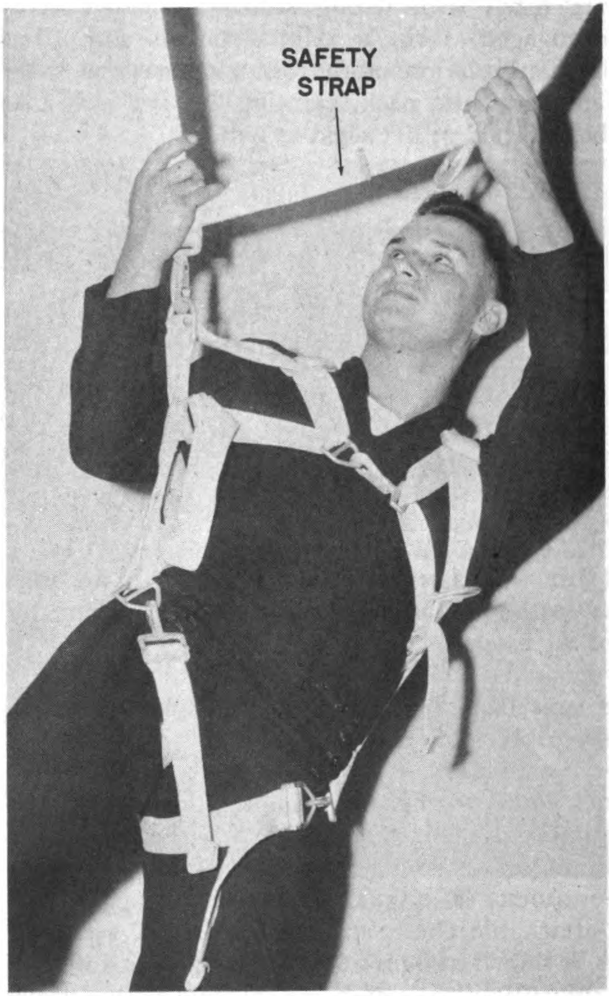


Figure 36. — Safety strap in operation.

PARACHUTE PACKS

The purpose of the parachute pack is to house and protect the pilot chute, canopy, and shroud lines. The pack is fitted with a quick-release device known as the RIP-CORD ASSEMBLY. When the rip cord is pulled, the sides of the pack are automatically drawn back and clear by the PACK-OPENING ELASTICS in order to permit the canopy to unfold and deploy.

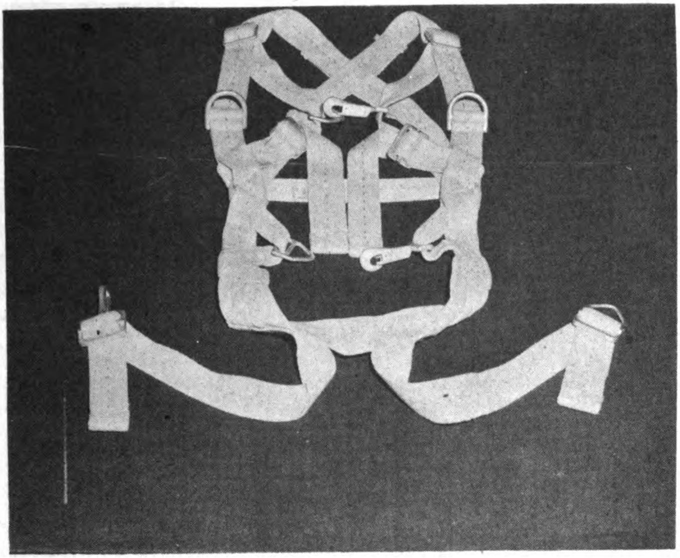


Figure 37. — Quick-fit chest type harness.

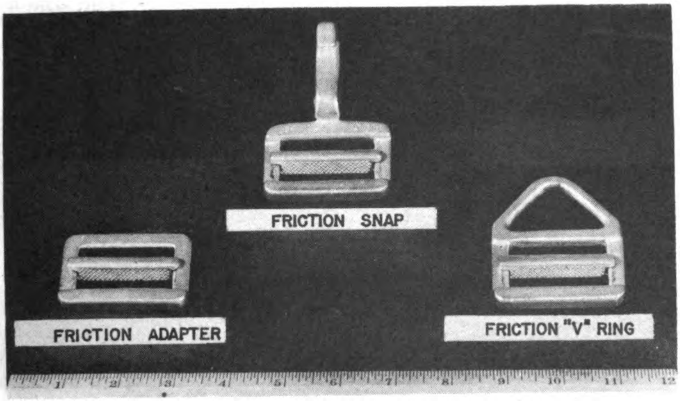


Figure 38. — Quick-fit harness hardware.

In figure 39, the QAC pack is shown in the inside, exploded, and outside views. The letters identify the component parts of this unit.

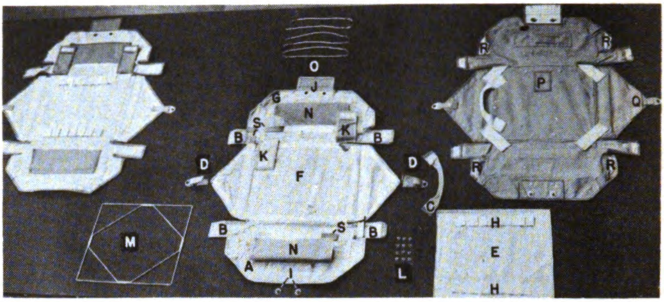


Figure 39. — QAC pack, showing inside, exploded, and outside views.

(A) Cone side flap
(B) Corner flap
(C) Carrying handle
(D) End tab
(E) False bottom
(F) Flat pattern (true bottom)
(G) Grommet side flap
(H) Hesitator loops
(I) Locking cones
(J) Locking cone protector flaps
(K) Lift web protector flap
(L) Pack eyes
(M) Pack frame
(N) Pilot chute protector flaps
(O) Pack opening elastics
(P) Packing data pocket
(Q) Rip cord pocket
(R) Side flaps
(S) Stiffeners

The following illustrations, figures 40 to 44, inclusive, show the different types of parachute packs in current use.

The parachute pack is constructed of high-grade plain weave cotton processed fabric. One side of the pack is colored aircraft gray, while the other is unbleached. A rectangular steel-wire frame is inserted between the true

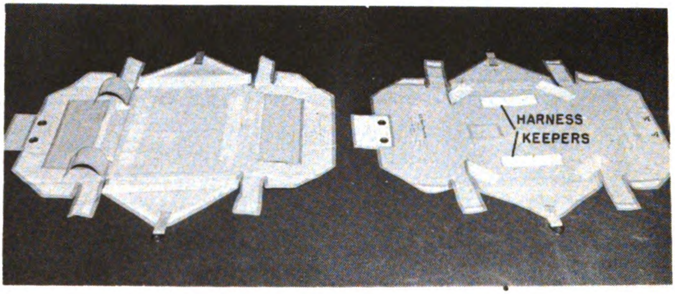


Figure 40. — SS pack, showing inside and outside views.

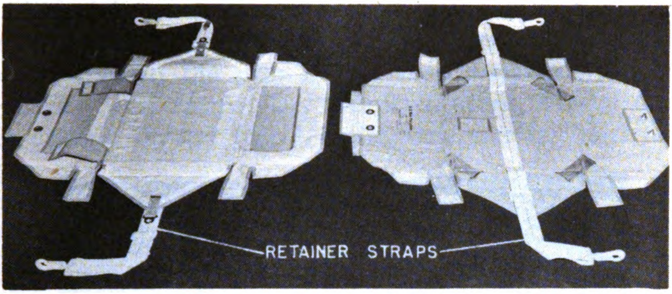


Figure 41. — QAS pack, showing inside and outside views.

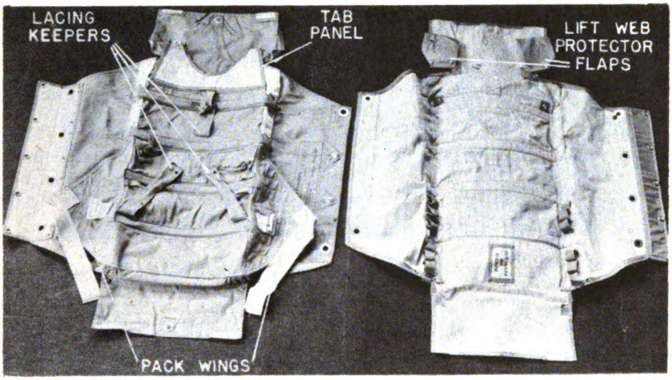


Figure 42. — SB pack, showing inside and outside views.

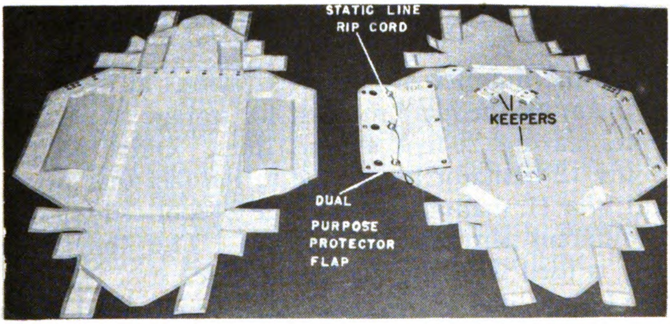


Figure 43. — TB pack, showing inside and outside views.

and false bottoms of the QAC, SS, QAS, and TB packs to maintain shape and rigidity. Numerous pack stiffeners, illustrated in figures 39 to 44, also aid in maintaining shape.

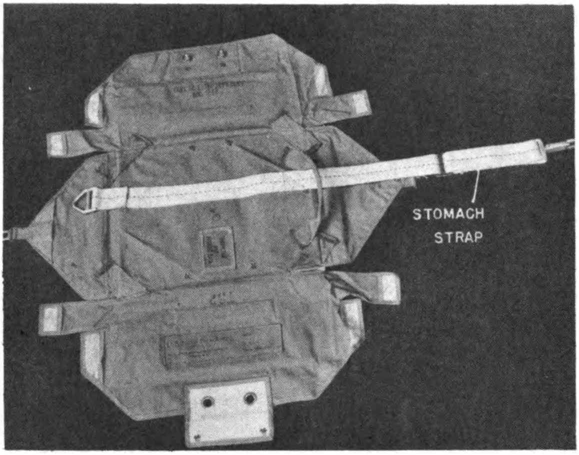


Figure 44. — TC pack, showing outside view.

The STANDARD BACK PACK shown in figure 42 is a SOFT PACK, the sole agents used to maintain its shape being flat curved steel springs arranged horizontally across the pack. The standard back pack is the only unit differing to any extent from other packs. The HESITATOR LOOP arrangement is basically the same, and is adequate for storage of 20-foot lines.

Notice the number of HESITATOR HOOKS in figure 39 — 16 of them, an adequate number for storage of parachute canopies having 20-foot shroud lines. Older SS packs had only 12 hesitator loops, due to the fact that prior to World War II, manufacturers made 24-foot canopies with two different shroud line lengths. The longer line canopy is used with the QAS parachute.

The longer lines of the QAC pack are intended to compensate for the short lift web assembly, compared to the longer lift webs of the standard seat unit. Manufacturers strived to maintain the PROJECTED DIAMETER, regardless of the different lengths of lift webs. With the war accelerating contracts to numerous parachute manufacturers, together with the desirable characteristics of interchangeability and Army-Navy standardization, 24-foot diameter canopy shroud line lengths were standardized to 20 feet.

Current 24-foot size parachute packs have sufficient hesitator loops to properly stow 20-foot shroud lines.

CONE SPACING

Notice the LOCKING CONES in figure 45. The measurement between the two cones from center line to center line is known as the CONE SPACING.

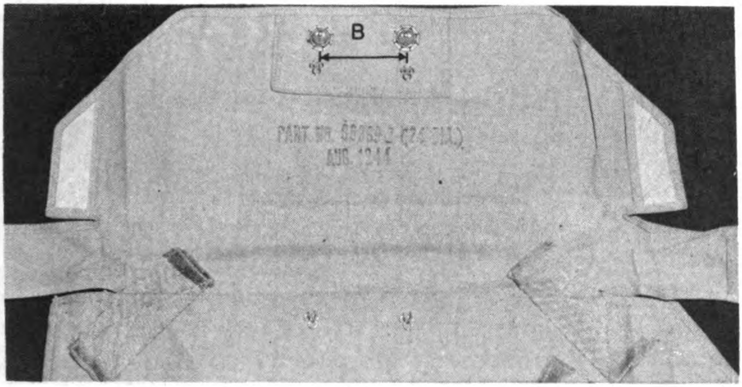


Figure 45. — Parachute pack cone spacing.

This spacing varies with parachute packs of the same type, although no particular reason exists save that of standardization. Current cone spacing is standardized on certain parachute packs, namely, the seat and chest types. When a rip cord is selected, the PIN SPACING MUST CORRESPOND TO THE CONE SPACING.

The egg-shaped END TABS in figure 40 seem to provide a smoother opening action to the side and end flaps.

ACCESSORIES

The RIP CORD ASSEMBLY is composed of a HAND PULL, CABLE, and SWAGED PINS, and is the standard manual releasing device used on Navy parachutes. This device holds the pack in a closed position while the rip cord pins are inserted in the pack locking cones. When the rip cord is pulled, the pack-opening elastics draw the side and end flaps back to free the chute. Figure 46 displays a variety of rip-cord assemblies, portraying both TRAPEZOID and CLOVER-LEAF shaped hand pulls.

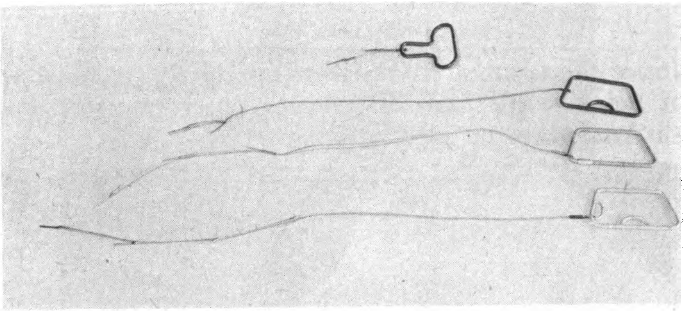


Figure 46. — Rip cord assemblies.
(Top to bottom: QAC, SS, TB, and SB.)

HAND PULL POCKET

The HAND PULL POCKET, a variety of which are shown in figure 47, positions the hand pull of the rip cord assembly in an accessible place. The pocket is so located that the parachutist can easily make the pull with the RIGHT HAND.

The CLOVER-LEAF design hand pull pocket is used on QAC and QAS parachutes, while the TRAPEZOID type is employed on SS and SB designs.

SEAT CUSHIONS AND BACK PADS

SEAT CUSHIONS simply afford the wearer greater comfort. The cushion has approximately the same rectangular area as the parachute container, and is filled with bound hair or foam rubber. An opening is provided in the forward portion of the cushion for passage of the leg straps.

BACK PADS are rectangular and comparatively flat in shape. The filler is the same as for the seat cushion, while the covering is 12-ounce cotton duck colored aircraft gray.

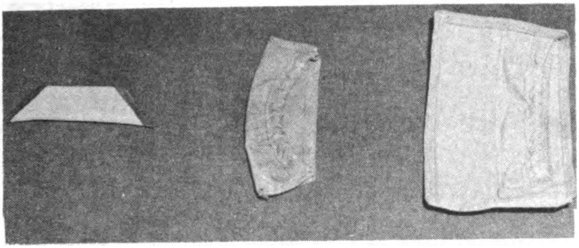


Figure 47. — Hand pull pockets.

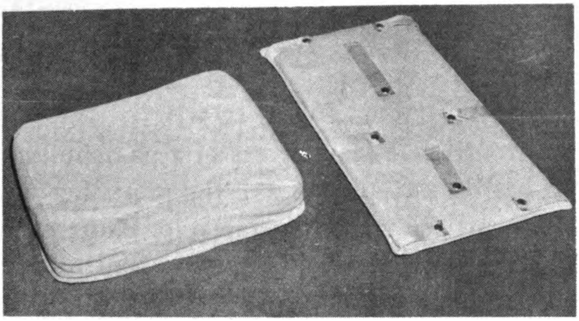


Figure 48. — Seat cushion and back pad.

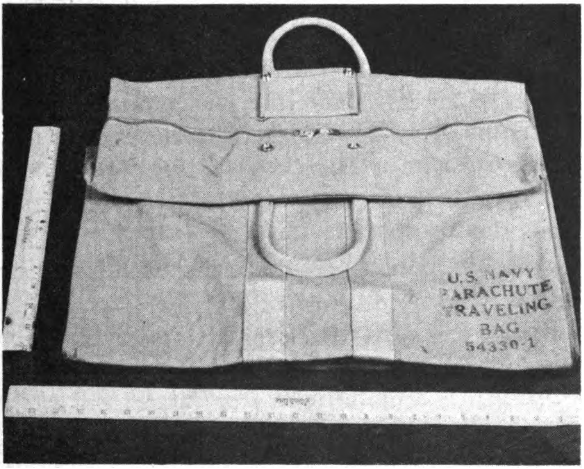


Figure 49. — Outside view of the parachute traveling bag.

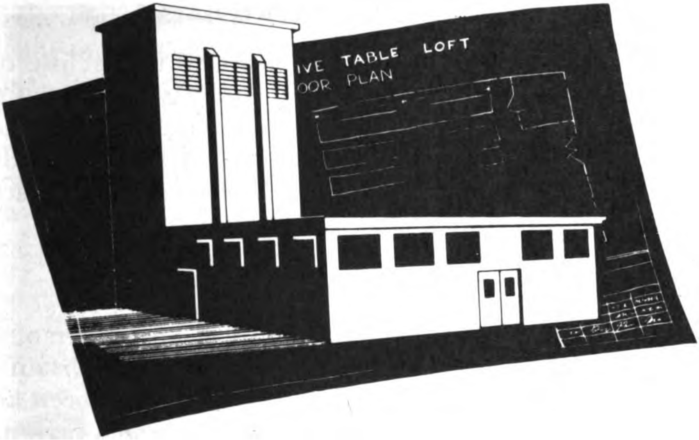
Small KEEPERS hold the pad snapped to the harness. In addition to affording comfort to the wearer, the pad retains the harness in a relatively secure and ready position for donning. Front and side views of these assemblies are shown in figure 48.

TRAVELING BAG

Parachutes, including harness and pack, require protection from dust and dirt while not in actual use, and this protection is provided by a fairly large canvas bag called the TRAVELING or CHAFFING bag, shown in figure 49.

QUIZ

1. What are the five major parts of a parachute?
2. What are the two purposes of the pilot chute?
3. What forms the frame for the pilot chute canopy?
4. What connects the shroud lines of the pilot chute canopy to those of the main canopy?
5. How many gores are there in the pilot chute canopy? In the main canopy?
6. How many rows of stitching join adjacent gores in the main canopy? What goes inside these rows?
7. What arrangement prevents the canopy from slipping along the shroud lines?
8. What is the name of the opening at the apex, or top, of the canopy? What is the function of this part?
9. How are the pack flaps opened when the jumper needs the chute?
10. How many panels are there in each gore of the canopy?
11. Why does the QAC pack have longer shroud lines than the standard seat unit?



CHAPTER 5

PARACHUTE WORKSHOP AND EQUIPMENT

THE LOFT

Whether assigned to a NAVAL AIR STATION OR TO A SQUADRON, the Parachute Rigger's duty will be to keep parachutes in perfect working condition. To properly perform such duty, a place in which to work and store essential equipment is required. The PARACHUTE LOFT is the servicing depot for parachutes, and the design of the loft should be such as to enable the Parachute Rigger to accomplish his work in an efficient manner.

To make for smooth operation, a receiving section must be provided where chutes can be brought into the loft for transfer to the dry locker. Another essential is the establishment of a delivery section where parachutes ready for issue may be loaded directly into trucks for outlying transfer or on-the-spot delivery and issue. Establishment of the receiving station, dry locker, packing table, and delivery section in a direct line will greatly facilitate an efficient flow of work.

CONSTRUCTION MATERIALS

The parachute loft should conform to the architecture of the station of which it is a part, and may be constructed of wood, brick, or any similar materials. All-steel construction is not recommended because of its high conductivity and sweating tendencies. The method of heating the loft will naturally conform to local conditions.

THE DOPE SHACK

Too little attention is devoted to the importance of the office or "dope shack" of a parachute loft. In certain instances, the only record of work performed has been kept in notebooks carried on the Parachute Rigger's person.

Because a parachute loft is primarily a lifesaving station, an up-to-date and complete record office is a definite necessity if good order and administration is to prevail.

STORAGE PROBLEMS

A major station may have a hundred or more parachutes on hand awaiting repair, issue, or shipment. Requirements of new squadrons and units should be anticipated, and required materials ready and waiting when needed.

A DEAD STORAGE SPACE is provided in small lofts operating with squadrons or other units. Such space is valuable for the storage of fabrics and other bulky stores drawn in excess of the main loft storeroom capacity.

STORAGE BINS

PARACHUTE STORAGE BINS OR RACKS should be made large enough to accommodate all types of service parachutes, including pararafts, in a fully-rigged condition.

The STANDARD BACK type, largest of service parachutes, offers itself as the logical pattern for storage bin design. A bin approximately 28 inches in length by 24 inches deep and 24 inches high is adequate for storage of the SB or any two other service-type chutes. The size may naturally be reduced to conform with working and storage areas as well as the general types of parachutes being serviced. In any event, bins should be of sufficient size so as not to chafe and injure parachutes.

Metal bins once furnished aboard ship were so small that it was barely possible to store a parachute with cushion and back pad attached. With the addition of the pararaft, these bins became wholly inadequate. A metal bin is satisfactory providing the edges have been properly finished and no nuts or bolts protrude to injure chutes or materials. Shore establishments generally use plywood construction because of its smooth and strong composition. The lowest row of bins should be at least 12 inches from the deck. Figure 50 illustrates a satisfactory bin section.

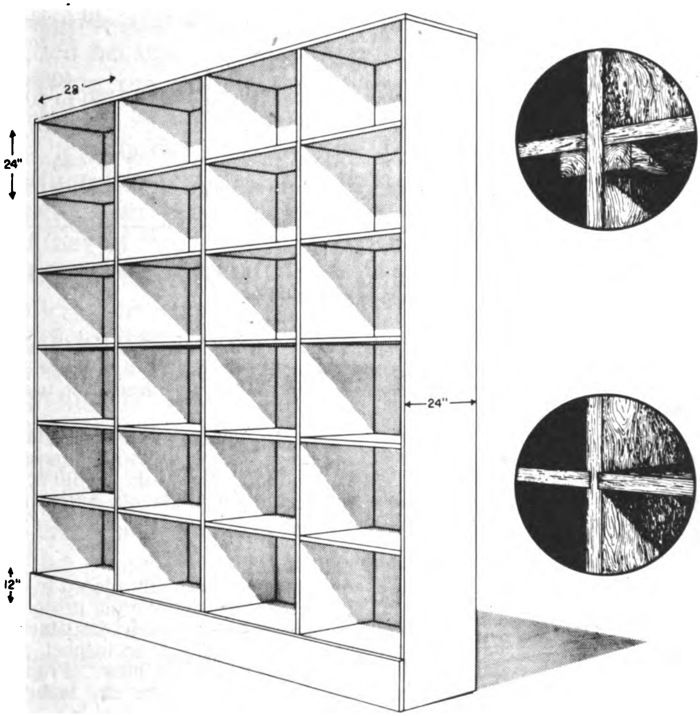


Figure 50. — Parachute storage bin section.

LOFT TEMPERATURE

The following chart (Table III) will be useful in determining the TEMPERATURE AND HUMIDITY RANGES for loft working spaces:

TABLE III

PARACHUTE LOFT TEMPERATURE AND HUMIDITY RANGES

Location	*Range*	*Temperature*	*Relative Humidity*
Dry Locker	Ideal	72 degrees	50%
	Safe average	65 to 80 degrees	40 to 60%
	Maximum	110 degrees	80%
Storage	Ideal	74 degrees	40%
	Safe average	65 to 85 degrees	30 to 50%
	Maximum	120 degrees	60%
Packing loft	Ideal	68 degrees	40%
	Safe average	55 to 82 degrees	30 to 60%
	Maximum	110 degrees	60%

EXPLANATION FOR TEMPERATURE AND HUMIDITY VARIATIONS IN DIFFERENT AREAS

Dry locker A more or less confined area.	Sets the pace and is considered as the ideal all-around condition. After the chutes leave here, they are rigged and packed for immediate use.
Packing loft A large, unconfined, area. Doors opening and closing constantly. Presents air-conditioning problems.	The effects of air conditioning on parachute fabrics begins breaking down here. If it is at all possible, the temperature and humidity range should be that of the dry locker and not on a par with unpredictable outside conditions.
Storage room A confined area.	Parachutes in storage are normally placed in some convenient carton or wrapping offering protection. The storeroom should be extremely dry since the chutes are wrapped and difficult to inspect. The added dryness insures against mildew. From the storeroom, chutes are sent to the dry locker for conditioning of the fabric prior to packing.

Temperatures of zero degrees F. plus excessive dryness create a large amount of static electricity in the atmosphere and seriously affect parachute canopies. The static electricity tends to hold the canopy closed, and prevents inflation — in other words, it creates a streamer.

Recent research has indicated that it is advisable to increase the dry locker humidity from the hitherto accepted

40 to 50 percent limit to one of 50 to 60 percent in order to permit greater absorption in the chute. The prevailing condition of static electricity on cold dry days is thus more or less obviated, and a normal functioning of the canopy is assured.

In tropical regions where the climate is extremely humid, it may prove necessary to maintain the lower range of 40 percent humidity in order to combat fungus growth.

In Table III, a maximum figure has been set for temperatures and humidity. This figure should not be exceeded because of the ruinous effect such a condition will exert on the assembly over extended periods. It is obvious that unflagging watchfulness is in order.

The majority of parachute lofts have no means of controlling temperature, nor are methods for such control provided in storage rooms or dry lockers. However, a number of large lofts are provided with efficient air conditioning units installed to control the air in dry lockers. Under these conditions, the best possible care can be devoted to parachutes, consequently guaranteeing a more positive operation and longer life of the assembly.

Table III recommends the ideal conditions. All three sections — dry locker, storage room, and packing loft — are theoretically under the control of air conditioning units. Only the expense of properly insulating the building, plus the installation and maintenance of the units, has retarded the project. Lofts thus equipped are in the vast majority, however.

Numerous instruments are available for determination of temperature and humidity. If you are operating in a region where the climate is ideal the year round, you would need only a HYGRODEIK, or a wet and dry thermometer, to check temperature and humidity. For accurate checks, however, a SLING PSYCHROMETER is recommended.

In areas where the temperature is not constant, an extremely close watch must be maintained. The HYGRO-THERMOGRAPH instrument records temperature and humidity every minute of the day, and this instrument may be used to determine whether temperatures and humidity are exceeding the safe average range.

SURVIVAL EQUIPMENT ROOM

You are also charged with the maintenance, repair, and installation of all survival equipment. The SURVIVAL EQUIPMENT or LIFE-RAFT ROOM is designed as a separate compartment from the parachute loft. A detailed design of this plant, together with the oxygen and CO_2 shop, is treated in a separate manual dealing specifically with this equipment.

METAL SHOP

A room or space separate from the packing section should be set aside for minor metal work such as soldering and similar types of repair. A strong work bench with a metal top, several vises, and a series of lower-locking bins constitute the major equipment requirements of the metal shop.

ISSUE STOREROOM

In large lofts, the storeroom is operated by a qualified storekeeper. In this room, all tools which are not personal property are kept for issue. All small parts drawn for operation of the loft are under the responsibility of the storekeeper who keeps a running inventory of material used and maintains an adequate stock supply.

FLIGHT GEAR ROOM

When the parachute loft is required to handle flight gear in great quantity, a separate room should be outfitted to accommodate such traffic. This room should contain a series of shelves for stowage, in alphabetical order, of repaired and unfitted flight gear. While awaiting issue, such gear is labelled with the pilot's name plate. If space permits, one or more sewing machines, a small work bench, and an embossing machine should be included in the flight gear room furnishings. The working spaces of a parachute loft must never be permitted to become a public thoroughfare.

LIGHTING

In any permanent parachute loft, the installation of flourescent lighting should be insisted upon. Flourescent lights have been found ideal for working with silk and nylon; other types of lighting produce a glare from the white surfaces of parachute canopies. The use of fluorescent lighting tends to increase production by eliminating eye-strain.

INFLAMMABLE GEAR LOCKER

A small building or locker for inflammable materials is located OUTSIDE the parachute loft, usually near the laundry and cleaning gear locker.

LOADING PLATFORM

A loft handling thousands of parachutes a month should be so constructed as to include a loading and unloading platform. Each platform should be provided with a covering to protect material in inclement weather.

LAUNDRY

The parachute loft laundry is a definite necessity, since it is imperative that facilities be provided for washing and drying chutes. At no time must a wet assembly be hung in a dry locker alongside relatively dry parachutes, and since hanging wet chutes out of doors is also a poor practice, the logical answer is a tub over which wet gear may be suspended. Such facilities require a high overhead, as shown in figure 51.

The most suitable location for the loft laundry compartment is next to the dry locker. The deck should be of concrete and complete with drain. Porcelain wash tubs, about the size of ordinary bathtubs, serve ideally for washing parachutes, and several shelves, a table, and two or three fans will satisfactorily furnish this unit.

DRY LOCKER

The dry locker is constructed primarily for the purpose of airing and drying parachutes.

The dry locker is a large room, its actual dimensions depending upon the number and types of parachutes to be serviced. During the drying period, parachutes are suspended by their peaks for 24 hours to permit the escape of moisture absorbed by silk or nylon canopies. In addition to shedding excessive moisture, many of the

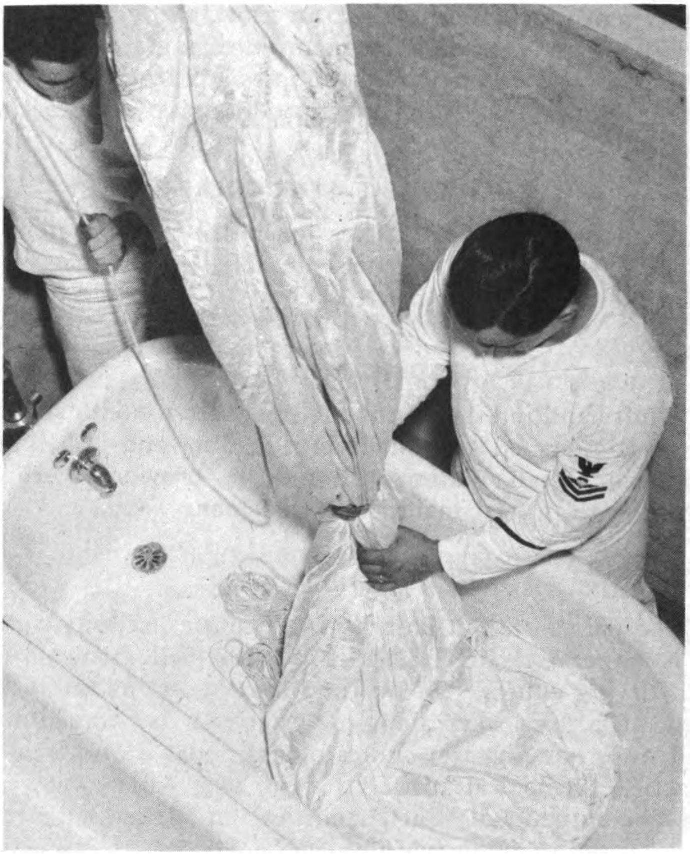


Figure 51. — Drying wet chute over a tub.

wrinkles in canopies disappear due to the weight of hanging and the circulation of air.

The tower should be constructed with a minimum number of doors and preferably no windows, so that the air conditioning will be easier to control. Metal finishing is not recommended in the construction of a dry locker because of the tendency of metal to sweat following sudden temperature changes. The dry locker deck must be perfectly free of splinters or abrasive characteristics. Decks fashioned of maple or oak make excellent wood surfaces; if hardwood is unavailable, battleship linoleum will serve the purpose admirably.

The height of the tower depends upon the types of chutes to be serviced, the method of suspension used, and facilities for securing the harness and container. Parachutes 28 feet in diameter require suspension lengths of 40 feet, compared to 35 feet required for 24-foot canopies. Under no circumstances should harness and pack be permitted to remain on the deck even though the height of the tower is insufficient.

In lofts where dry lockers are small, long, and narrow, the practice is to suspend packs and harnesses from coat-hangers or cleats fastened to the bulkhead, thus suspending the units free and clear. If heights are insufficient, the shroud lines may be chained to shorten the parachute lengths. Figure 52 illustrates two chutes of equal length suspended side by side, the unit shown on the left being chained.

There are many reliable methods of suspending parachutes, one of which is described below.

A pad-eye secured to the overhead, acting as an attachment point for a pulley capable of withstanding a load of 250 to 500 pounds, forms an overhead purchase. A sash cord or signal halyard is riven through the pulley and secured to itself to form a continuous loop. Woven or braided cord is the line best suited to the job since it will not twist as will ordinary line. A halyard snap is fastened at one point on the cord to permit total suspension of the canopy and a second snap is secured at a point which will be in a securing position with a stanchion or cleat when the chute is fully run up. Securing of the latter snap holds the parachute in position for drying.

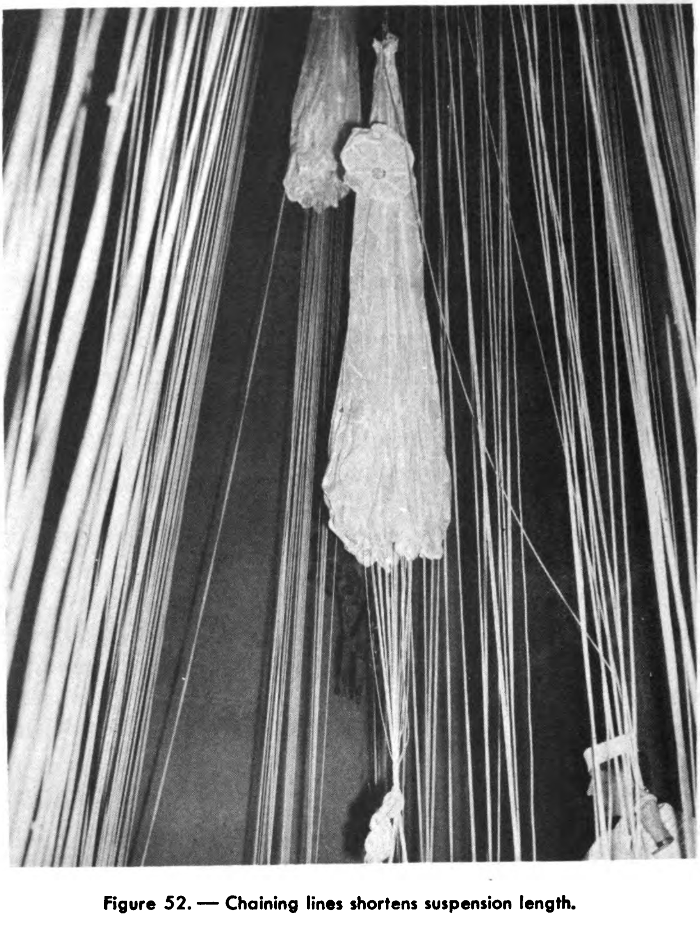


Figure 52. — Chaining lines shortens suspension length.

Electric light bulbs produce considerable heat, and silk or nylon permitted to come in contact with an unprotected and lighted bulb will be seriously damaged. Exposed lighting is therefore strictly taboo for dry locker illumination, inasmuch as suspended canopies invariably touch bulkheads.

For safe illumination, FLUSH LIGHTING is recommended. In this method ordinary electric light bulbs or fluorescent tubes are recessed and covered with sheets of frosted glass. Sufficient lights of this type should be installed to completely illuminate every surface of the dry locker.

To properly air and dry parachutes without the use of a dry locker presents something of a problem, especially aboard ship. There are, however, ways and means of circumventing this difficulty. Shipboard parachutes may be aired and dried in a chaffing bag, for example, according to the following procedure.

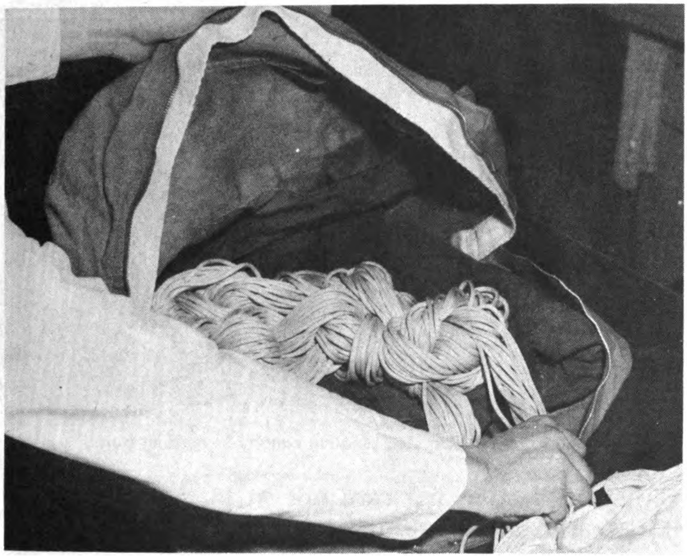


Figure 53. — Accessory items stored in chaffing bag pockets.

Lay the chute on a table or tarpaulin and shake out all folds. Secure the pilot chute. Place harness and container in the bottom of the bag, taking precautions to prevent the hardware from coming in contact with the canopy and shrouds. If necessary, use the inner pockets of the bag for the storage of miscellaneous accessory items. This procedure is demonstrated in figure 53. Then store the shrouds and canopy by chaining the former and flufting the latter back and forth, "accordion pleat" style, inside the length of the bag. Place the pilot chute between the container and canopy. This method of stowing the canopy in the chaffing bag is shown in figure 54.

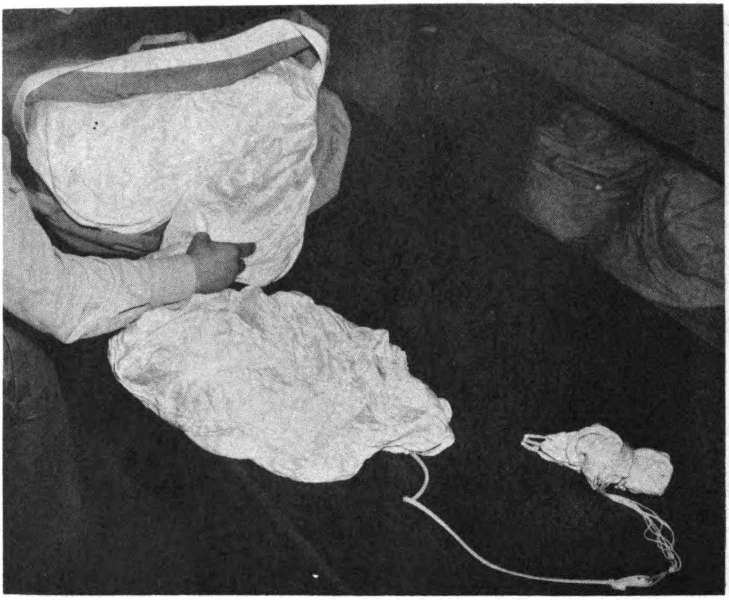


Figure 54. — Accordion-pleating canopy in chaffing bag.

Close the bag, taking care not to snag the fabric, and making certain that nothing has been left outside.

Another method, commonly used aboard ship for airing and drying parachutes, is the spread-drying technique.

Locate a clean storage compartment within a good temperature drying range. Remove shoes, and spread bed sheets or any clean cloth over the deck area. Crack and shake out the parachutes, spreading out the canopies in any manner which presents itself as best for drying. Figure 55 illustrates this method of spread-drying chutes.

Whenever possible, shipboard parachutes should be taken ashore for thorough drying and airing under more ideal conditions.

PORTABLE DRY LOCKERS

Portable dry lockers constructed mainly of canvas and a minimum of framework have been used with a fair degree of success. They are recommended for use when the number of chutes to be serviced is small and the time allotted to such servicing limited.

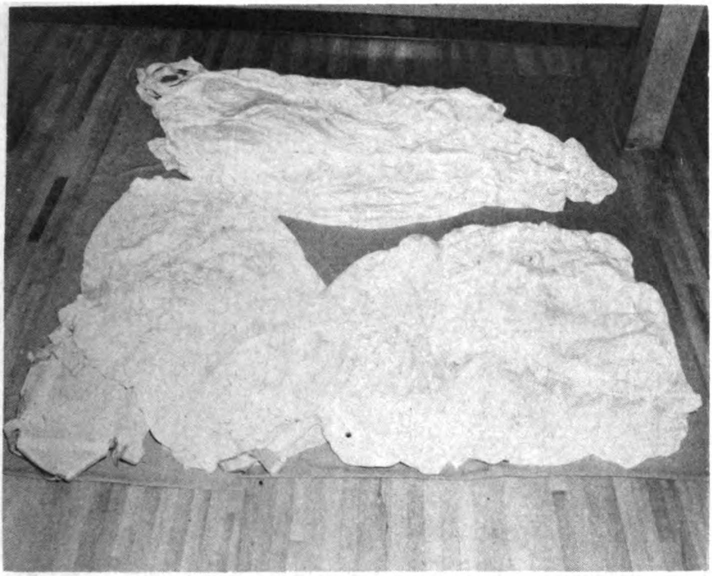


Figure 55. — Spread-drying canopies on deck.

Portable dry lockers are valuable for use with a squadron operating in an isolated area, as well as for temporary use during construction of a new base.

This type of dry locker is not very sturdy, and it by no means completely supplants the conventional type of unit. The portable rig will, however, furnish a limited amount of protection against sunlight, light rain, and heavy dew. It is quickly assembled, and can be manufactured locally.

Actually, all that the portable dry locker construction entails is a high square tent six or more feet square and approximately 18 feet in height. A collapsible square frame provides the shape at the top as well as at points of attachment for suspension lines. Sandbags spotted on the ground, with securing-loop attachments, serve as anchorages for the lines. The top, about two feet in height and pyramid-shaped, terminates in a steel ring which furnishes a single point of suspension for the center locker, and the bottom is formed by a built-in ground cloth. Entrance may be gained at the side through an L-shaped aperture held closed by slide fasteners. The bottom corners and inner guy-lines are anchored to stakes driven into the ground to provide stability.

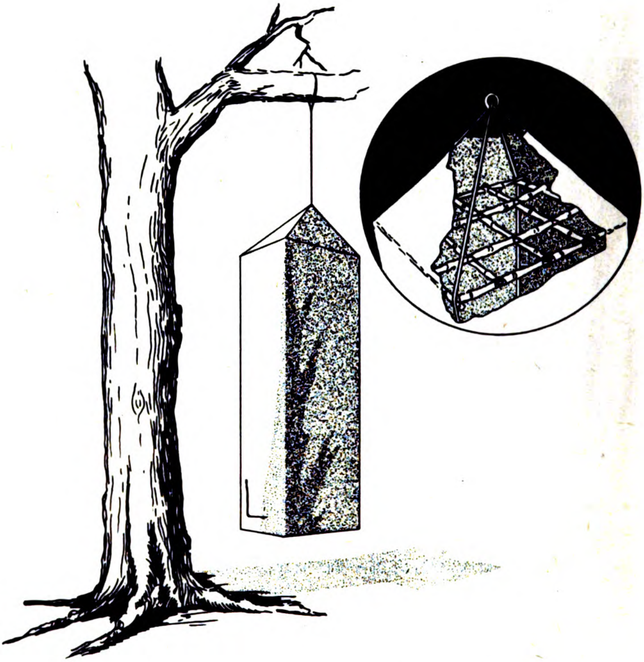


Figure 56. — Suspension-type portable dry locker.

The portable tower may be suspended from a tree or boom rigged outward from the side of a precipice. The suspension-type portable dry locker is shown in figure 56.

If the tower is to be constructed of waterproof or water-repellent fabric, provision for ventage is necessary to prevent sweating. Installation of a protective lining prevents the waterproof material from staining the parachutes. Nine chutes may be aired and dried at one time by suspending them a foot from the walls and two feet apart. The suspension dry locker will prove useful aboard ship provided an out-of-the-way location can be found.

Another type of portable dry locker, of a more permanent nature is approximately 20 feet square and constructed mainly of pipe and canvas. The pipe forms the rigid framework for the canvas covering, and is easily assembled. A locker of this size has a capacity for drying about 60 parachutes, and is sufficiently large to accommodate a dehumidifying machine.

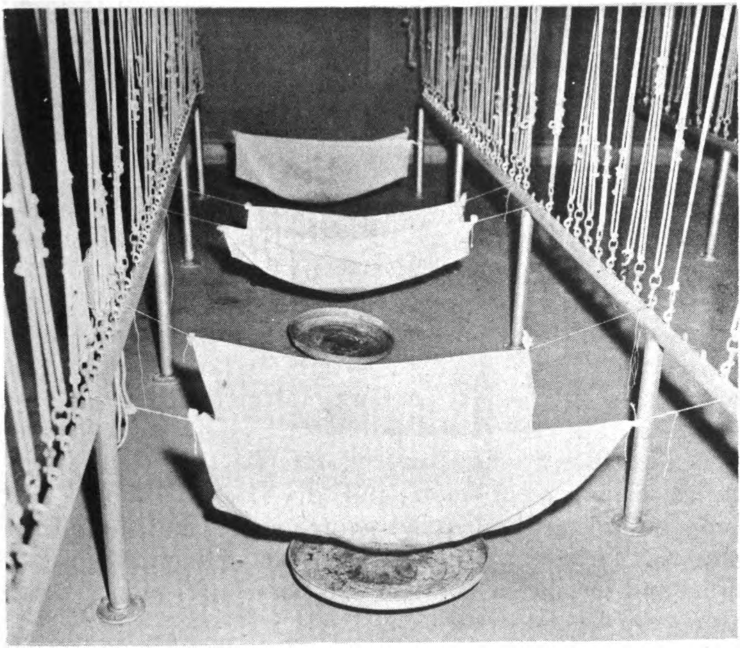


Figure 57. — Moisture catchers.

"MOISTURE CATCHERS"

Difficulty may be experienced in keeping dry locker humidity within proper proportions during tropical rainy seasons, regardless of the extent of air conditioning facilities. Under such conditions, MAGNESIUM CHLORIDE, a chemical which absorbs the moisture in the air, will be very useful.

Set up a number of cheesecloth nets about two feet square and tied at the corners for suspension two feet from the deck. Place several handfuls of magnesium chloride in each net and provide drip-pans for catching the water. When the chemical has absorbed and shed a considerable quantity of water it has a tendency to solidify. It must then be broken up so as not to impede its absorbing effects. Figure 57 shows a number of such nets in action.

The temperature and humidity of the dry locker must be frequently checked if a reliable drying pattern is to be effected. The various instruments applicable to recording temperature and humidity will be discussed later in this chapter.

LOFT-DRY LOCKER COMBINATION

Small units, squadrons, or stations with light work loads have successfully used a loft built into a hangar or other available space. The average measurements of this type of loft are 50 feet in length by 15 feet wide. The dry locker in this case may be an open well about 15 feet square and 35 feet in height, with room for from 16 to 25 suspension lines. The packing table may extend somewhat into the well where the harness and containers are hung from overhead hooks secured to the bulkhead. The entire arrangement — loft and dry locker — should be kept within recommended temperature and humidity ranges. This type of loft is capable of handling small units and serving as many as 300 parachutes monthly, an average of 15 chutes each day.

DRY LOCKER NOTES

Normally, a distance of two feet is permitted between the bulkheads and suspended parachutes. Chutes are spaced between two and three feet apart and hung SINGLY on each line. If single suspension is impossible, a longer drying period — in excess of 24 hours — is recommended.

WET OR DAMP parachutes should not be hung in the dry locker along with relatively dry chutes. The hygroscopic properties of silk and nylon fabrics must always be borne

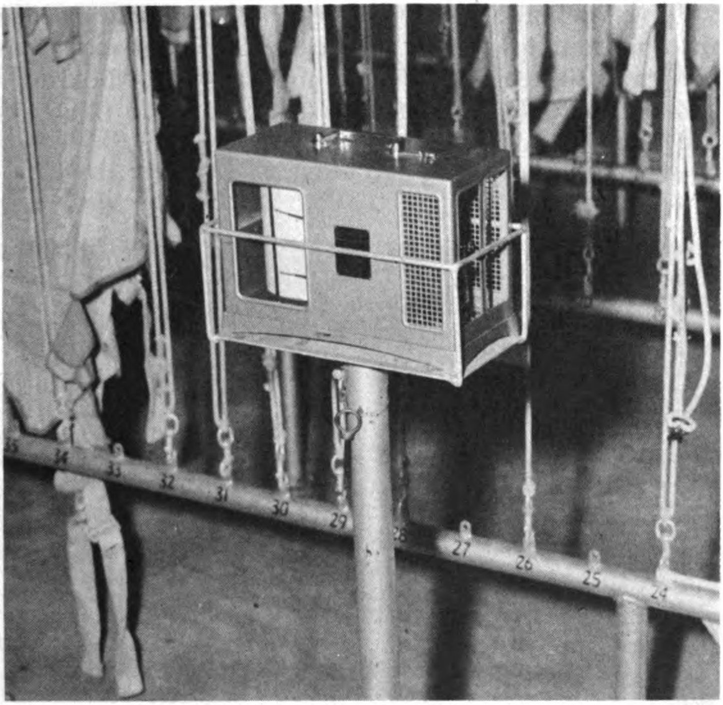


Figure 58. — Telescoping hygrothermograph stand.

in mind. Wet parachutes may be dried in a separate compartment known as the WET LOCKER, or in the loft laundry suspended above wash tubs. Electric fans should be used throughout most of the drying period.

A dry locker outfitted with swinging doors should never be left open. This type of entrance is best suited to the task of carrying chutes to and from the packing loft.

Maintain the dry locker in an immaculate condition at all times. This compartment is to be used strictly for the purpose of airing and drying chutes and never as a warehouse or storage space for personal gear. SMOKING IS NOT PERMITTED AT ANY TIME!

For close and accurate checks on the efficiency of the air conditioning unit, install a telescoping stand extending as high as 30 feet into the air and capable of holding a HYGROTHERMOGRAPH. This unit, illustrated in figure 58, will permit readings at various levels.

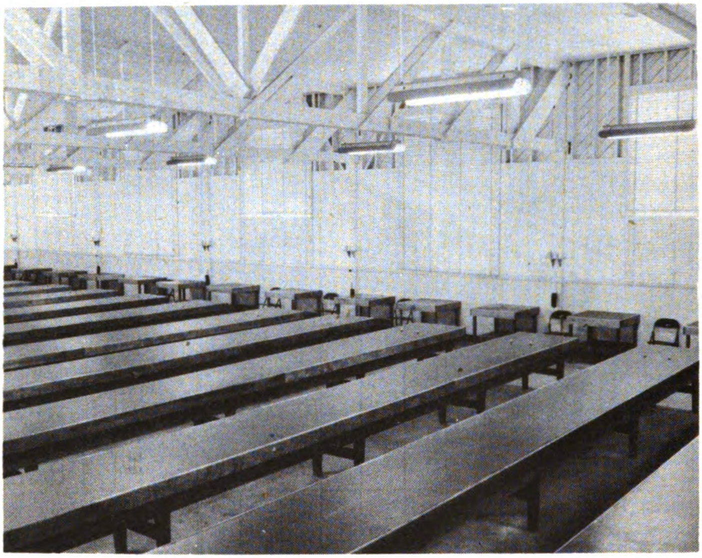


Figure 59. — Standard packing tables.

It is fully as important to air and dry parachutes as to inspect and pack them for foolproof operation. Moisture plus handcreases and folds plus time will greatly weaken fabrics. The conscientious Parachute Rigger will check and re-check temperature and humidity ranges whenever parachutes are hung up to dry.

STANDARD PACKING TABLE

The standard parachute packing table is 40 feet long, three feet wide, and three feet high. This table is capable of handling chutes up to 28 feet in diameter with shroud lines approximately 22 feet in length. Figure 59 shows a group of standard packing tables. Construction of these tables is necessarily rugged, since the units must withstand continual hard usage, especially at the packer's end.

One of the most important features of the packing table is its FINISH. The table top is usually covered with highly-polished linoleum and edged with one and one-half inch to two-inch molding. Figure 60 illustrates the details of the standard packing table.

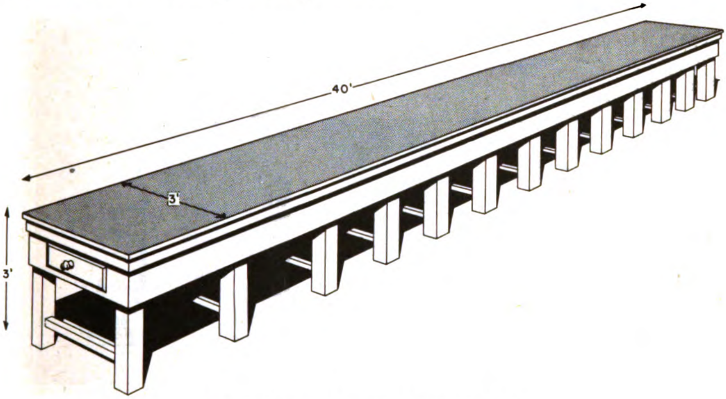


Figure 60. — Standard packing table.

As shown in figure 61, each packing table is provided with some type of attachment which secures the parachute under tension for inspection and packing. Figure 61 pictures three of the most popular methods of securing parachutes under tension.

Figure 62 is a detail drawing of the attachments illustrated in figure 61.

CUT-AWAY TABLE

Many technicians prefer the features of a "cut-away" packing table to that of the conventional design, since the narrow section of this table permits closer work at the packer's end, especially in such details as closing and finishing the pack.

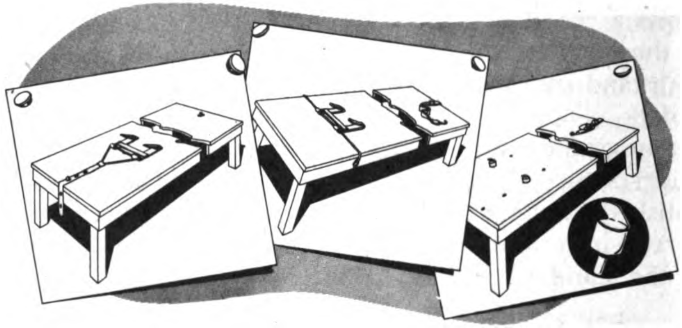


Figure 61. — Packing table attachments.

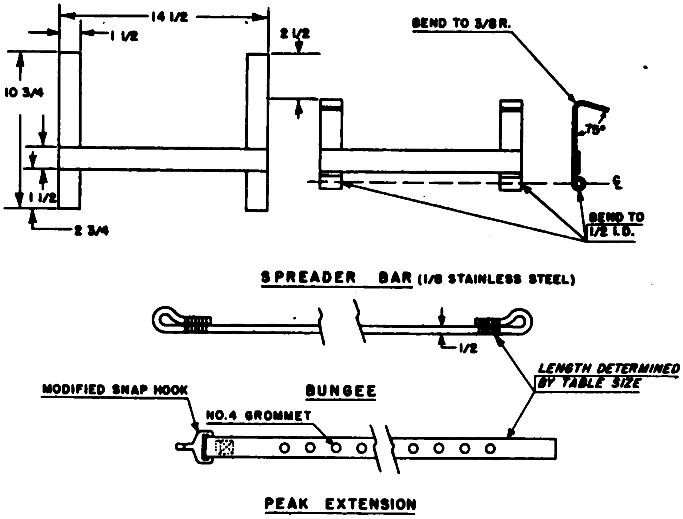


Figure 62. — Spreader bar, bungee and peak extension.

The disadvantages of the cut-away table lie in the narrow end where canopies are more apt to drag on deck. In laying out and cutting of materials only the wide end can be utilized.

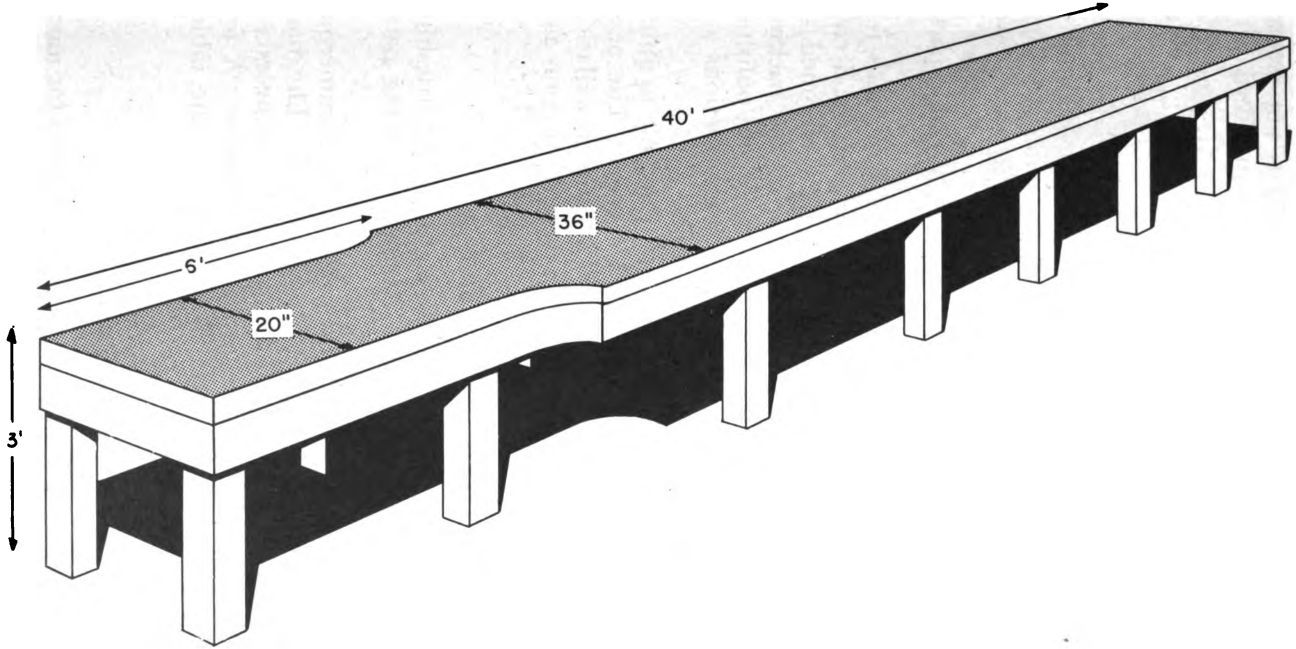


Figure 63. — Cut-away packing table.

The cut-away packing table (figure 63) is not recommended for small lofts where one table is required to carry every sort of workload.

PORTABLE TABLES

The primary characteristics of any portable equipment are that it be light in weight and sufficiently strong to perform its function without requiring excessive maintenance.

Portable packing tables are easily stored and consequently are handy items for shipboard or wherever a regular parachute loft is not available. A portable packing table is shown in figure 64.

The top of the portable table is made in sections ten feet in length, and constructed of 5/8-inch plywood covered with battleship linoleum and properly trimmed to prevent possible snagging of the silk during the packing process. The linoleum need only be waxed and polished to give it a smooth surface. Four of these sections are sufficient to handle all service parachutes.

Cleats are secured to the underside of the table to guide and position each section on ordinary horses. The peak table section and opposite section all require installation of applicable tension fittings for parachute inspection and packing.

MESS-HALL TABLES

Aviation Parachute Riggers serving aboard battleships and cruisers often use mess-hall tables for packing parachutes.

This is not considered a good practice since numerous difficulties arise in scheduling and planning. The handling of mess-hall tables and the setting up of necessary additional equipment is a cumbersome business. A finished tarpaulin should always be spread over the tables before work commences.

"DECK PACK"

"Deck packs" are accomplished where facilities for more conventional packing are not available. The "deck pack"

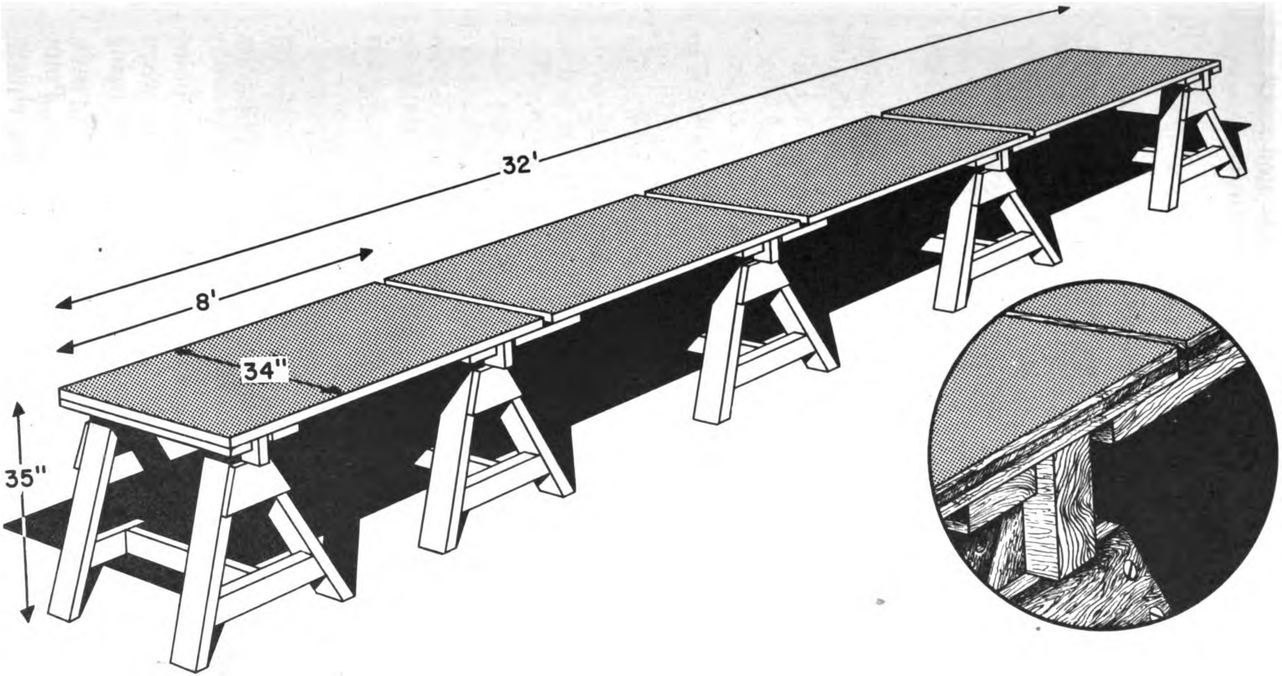


Figure 64. — Portable packing table.

is an emergency pack, and a chute so arranged must be repacked in a parachute loft as soon as possible.

FABRIC CUTTING TABLES

The size of a cutting table depends on the width and general length requirements of the material to be prepared. Fabrics used in parachutes are generally woven to 36-inch widths. Thus, a table of similar width is required, although very often a wider table is definitely necessary. When two or more lengths of 36-inch fabric are being sewn together a table six feet wide is better suited for the work.

Where space is available, cutting table widths of six feet and lengths of 12 feet are recommended. These should be finished in the same way as the packing tables.

SHROUD LINE CUTTING TABLE

Figure 65 illustrates a shroud line cutting table used to cut a complete set of lines for a 24-foot standard canopy. Notice weight (A) on the right side of the table. One end of a continuous shroud line (cordage) is tied to its handle to run up and over sheave (B), directly down to sheave (C), up the table to sheave (D), back to sheave (E), around sheave (E) and up to sheave (F), and so on until sufficient line is run off to comprise a 24-foot canopy. The end of the line is then passed under sheave (G) on the left side of the table, run directly up and over sheave (H), and tied to weight (I). The weights do not remain on the table, but are suspended so that the lines may become taut for marking.

These weights vary according to the type of shroud line (silk or nylon) being cut, and serve to hold the lines under a specified tension.

Cross-piece (1) represents the 10-inch marking point and is fitted with a hinged locking board which, when locked in place, holds the lines from shifting while being marked. Cross-piece (2) is the skirt marking point, while cross-piece (3) represents the vent marking. Point (4) carries the peak sheaves. (Notice that the sheave carrier at the far end of the table appears to blend into the cross-piece 17 inches before it. This is the vent marking point).

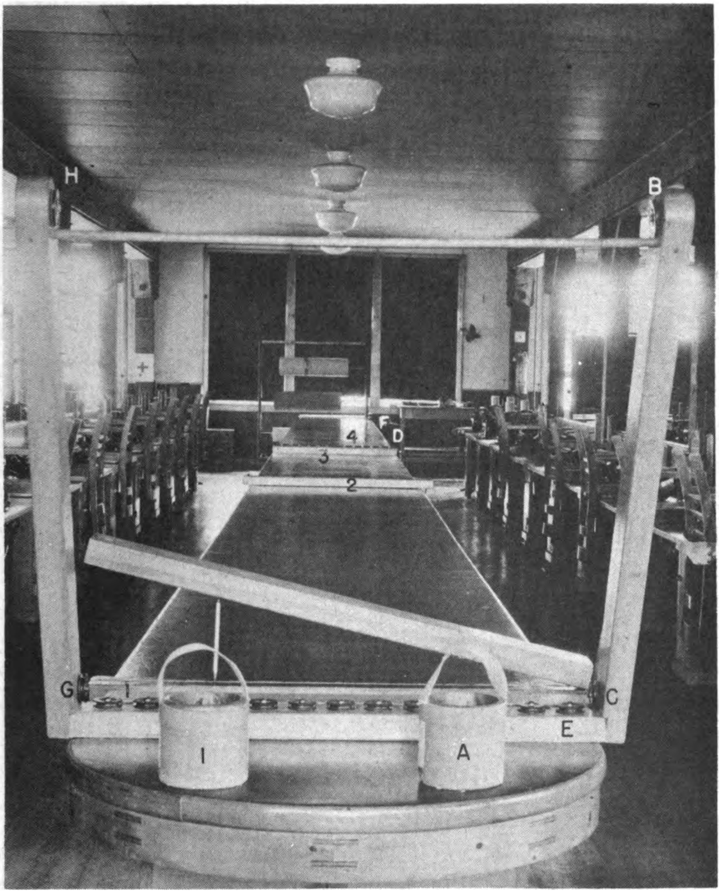


Figure 65. — Shroud line cutting table.

The lines are cut at the center line marking point of each sheave located at this end of the table.

The shroud line cutting table is considered major overhaul equipment.

FABRIC CONVEYORS

Fabric fresh from the looms is generally rolled into bolts for packing and delivery, and thus it is received for parachute manufacture and repair. The majority of these bolts weigh more than 150 pounds apiece, rendering shop handling somewhat difficult unless provision is made for transporting the fabric from point to point.

A FABRIC CONVEYER of simple, strong design, shown in figure 66, will serve this purpose admirably. Notice the large rubber casters and heavy two-inch pipe and iron beams. This unit was constructed to withstand a load of 700 pounds.

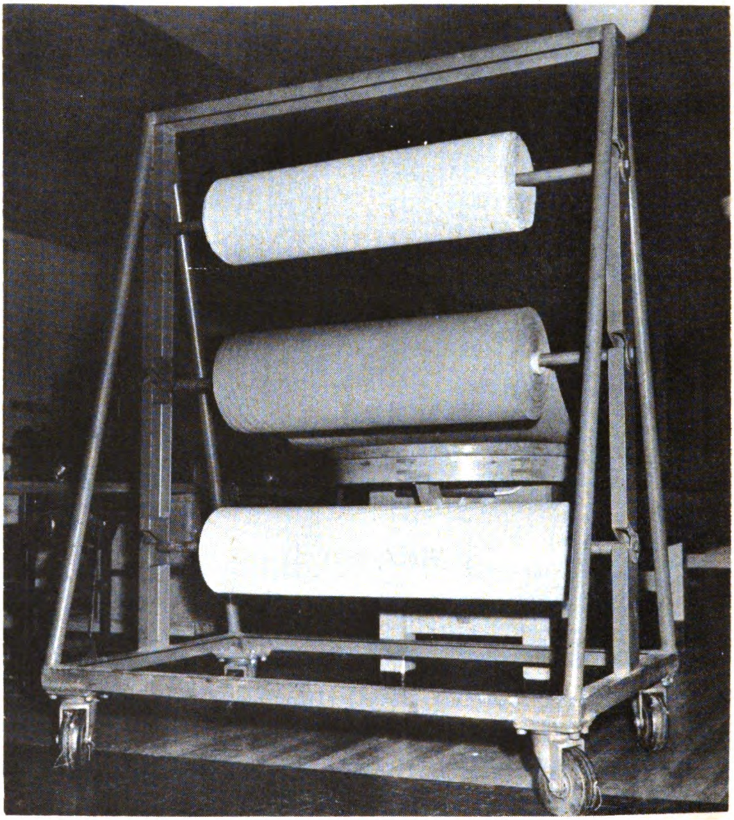


Figure 66. — Parachute loft fabric conveyor.

STENCILING TABLE

Stenciling tables are essential equipment for large lofts and overhaul shops. This unit not only provides a filing place for all stencils, but confines the somewhat messy task of cleaning stencils and brushes to one area. The special marking ink (ultramarine in color) is placed in a well, and a side drop-leaf may be fitted with an absorbent pad for the purpose of working excessive ink from stencil brushes. In figure 67, notice the replaceable canvas cover.

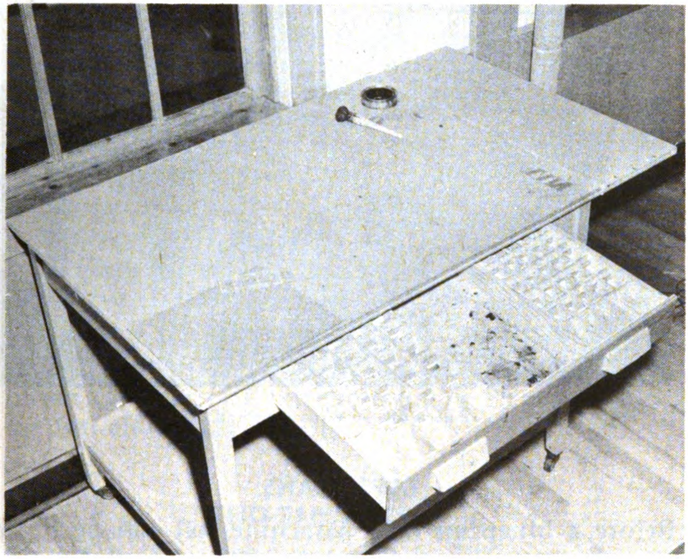


Figure 67. — Stenciling table.

WAX POT STAND

Wax pot stands are simple to construct and a necessity in any loft. Because of the ever-present hazard of overheating, metal is the most efficient construction material, although a wooden frame provided with a metal top is a safe design. Figure 68 illustrates drying dowels which are handy contrivances for hanging short sections of waxed webbing for cooling.

Compressed air is an excellent medium for blowing out lint and thread from sewing machines. All that is required is a standard-sized compressed air cylinder, a reducing valve, and a length of hose. A dolly is used in transporting the cylinder about the loft.

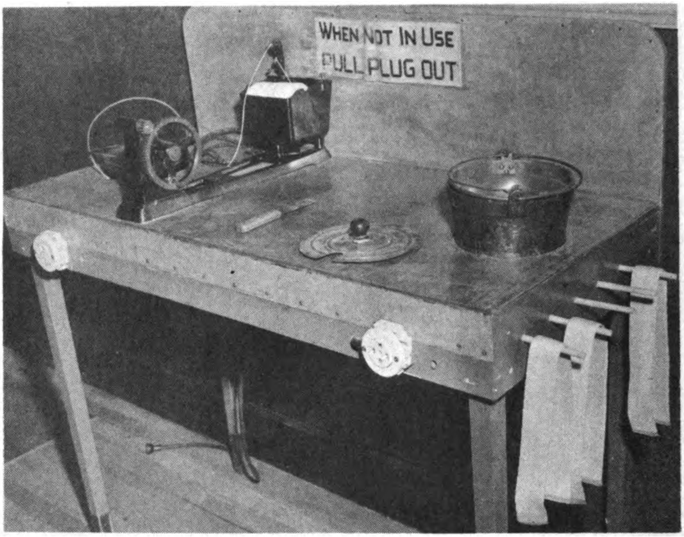


Figure 68. — Wax pot stand.

LOFT PLANS

Before a blueprint of a parachute loft can be drawn, the amount of space needed for the general layout of equipment should be furnished by the Parachute Rigger.

Loft plans presented in this discussion are by no means dogmatic citations of regulations, but merely the product of long study and experience. The presentations are intended to demonstrate various methods of laying out a loft with the object of attaining the smoothest possible flow of work and elimination of lost motion.

Skylights may be required in large lofts to supply additional light and ventilation. Skylights should be fitted with frosted glass panels to prevent direct sunlight from striking packing tables.

Lofts built as separate structures should be at least of

TWO-TABLE size, and include an office, storage room, and working space. The number of chutes packed would seem to indicate a ONE-TABLE loft as sufficiently large, yet the number of men assigned to sewing machines and other duties, along with storage requirements, make a loft of two-table capacity practically mandatory.

If an air conditioning unit is not installed during construction, allowance should be made for doors of sufficient size to accommodate bulky equipment at a later date.

ONE-TABLE LOFT

The one-table loft is designed to occupy space in a hangar or other structure, but such an arrangement is confined mainly to packing of chutes. Life rafts cannot be inspected and packed in such confined areas as the talc used would set up harmful abrasive conditions in parachute canopy fabrics.

Figure 69 gives the floor plan for a one-table loft. In section (A) of this drawing, the dry locker is shown as an open well over one end of the table, and in section (B), the dry locker is separate from the packing space. The maximum capacity of a one-table loft is 25 parachutes a day, or 500 chutes per month.

TWO-TABLE LOFT

This loft is designed for outfits handling air groups, squadrons, or transient units. Adequate facilities are required for storing life rafts, jungle kits, cruise boxes, and other related equipment, as well as to permit handling and storing of service and lifesaving materials.

Bureau changes, manufacture of fluorescent units and signal flags for landing officers, special covers, bags, and all other required work can be accomplished in a two-table loft, similar to the type shown in figure 70.

The tower in this loft extends over the cleaning room, separated from the dry locker by a full bulkhead. Dry locker capacity is 56 parachutes per day, or approximately 1000 chutes per month.

FIVE-TABLE LOFT

The five-table loft can handle major repairs and complete servicing of all emergency lifesaving equipment. Two of the tables may be used, when required, by packing crews. Figure 71 suggests a floor plan for the five-table loft.

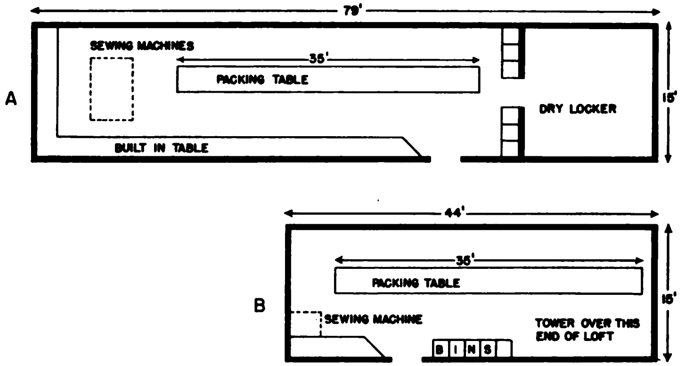


Figure 69. — One-table loft floor plan.

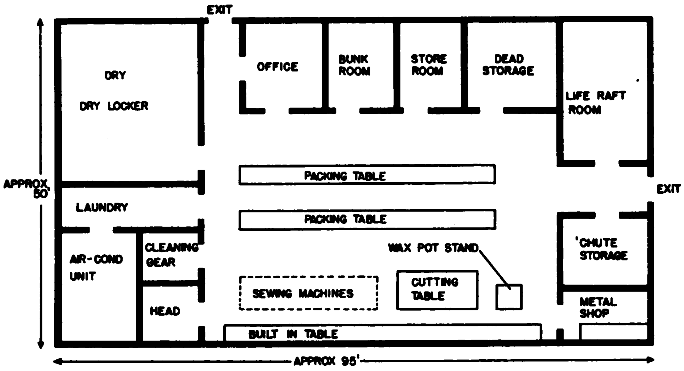


Figure 70. — Two-table loft floor plan.

INSTRUMENT READING

THE HYGROMETER. Ordinary air is a mixture of several gases, chief of which are nitrogen, oxygen, carbon dioxide, and evaporated water called WATER VAPOR. Air contains a practically fixed quantity of nitrogen, oxygen, and carbon dioxide, but the amount of water present varies over a wide range. It is the amount of water vapor in the air that determines our comfort to a great degree.

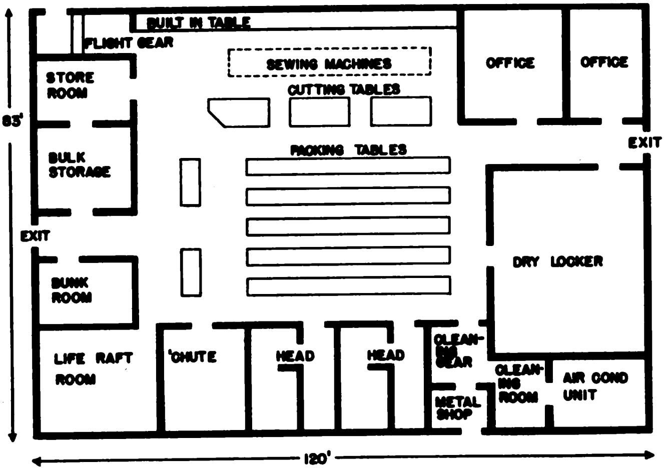


Figure 71. — Five-table loft floor plan.

The HYGROMETER is an instrument used for measuring the amount of water vapor present in the atmosphere. The most common form of this instrument is the wet and dry bulb thermometer. In order to understand how this instrument works and the manner in which human bodies are affected by water vapor in the air, we must understand something of the behavior of the component elements.

All matter is divided into infinitesimal particles called MOLECULES, which are in constant motion. Molecular speed depends upon the temperature of the body of which they are a part. When water is exposed to the atmosphere, some of the molecules of water project into the air, while others present in the air shoot into the water. Normally, a greater number of molecules leave the water than enter it, causing evaporation to occur. If, however, the number of molecules leaving the liquid surface is equal to the number entering, the air is said to be "saturated," and if more molecules enter the water than leave it, then "condensation" takes place. Thus it may be seen that the rate of evaporation depends upon the number of molecules already present in the air.

On the surface of the water is a thin film through which the molecules must crash upon leaving the liquid. This permits only those molecules moving at the highest speed to escape into the air. Since water is constantly losing its fastest-moving molecules through evaporation, those left behind have a lower temperature and are slower moving. Thus, water appears to be cooled by evaporation.

The wet and dry bulb hygrometer makes use of these principles. As the name implies, this instrument consists of two thermometers, the bulb of one being kept constantly moist. As the water evaporates, the bulb of this instrument is cooled, giving a lower reading than that of the dry unit. The faster the water evaporates, the lower the reading on the wet bulb thermometer. If no evaporation occurs (if the air is saturated), both thermometers will give the same reading.

Knowing both wet and dry bulb temperatures, the absolute and relative humidity may easily be determined from carefully prepared charts accompanying each instrument.

Human bodies react much like the wet-bulb thermometer. Nature supplies moisture to human skin to insure evaporation and consequent cooling. Because of this, a temperature of 68 degrees may be completely comfortable when humidity is high and evaporation is slowly taking place, while a temperature of 75 degrees in dry air may prove uncomfortably cool.

The amount of water vapor which a given volume will hold is dependent upon the temperature alone. A cubic foot of saturated air at 30 degrees F. contains only 1.94 grains, while a cubic foot of saturated air at 70 degrees F. contains 8.07 grains. Hence, if air at 30 degrees F. was taken from the outside into the packing loft and heated to 70 degrees F. without supplying moisture, the *relative humidity* would be 1.94 divided by 8.07, or 24 percent. This shows the necessity for supplying moisture to the air in artificially-heated lofts, if the relative humidity is to be constantly maintained at a packing figure.

PROPER CARE OF THE HYGROMETER. Keep the wick moist. Do not use a wick long after it has dried.

Locate the hygrometer on an inside wall.

In replacing the wick on the wet-bulb thermometer, it is important that the bulb be covered with a single piece of thin soft fabric. On cylindrical bulbs, this covering should take the place of a close-fitting jacket, and should be either sewn or plaited.

Strands from the bulb should be fitted about the bulb-neck in a close tie, and led off to the water receptacle.

The water cup should be kept nearly filled with clean rain or distilled water.

In extremely damp weather, wipe the bulb clean with a soft cloth before an observation is taken.

Ordinary types of hygrometers are not adapted for use in temperatures below the freezing point (32 degrees F.). When humidity is to be measured in sub-zero temperature, the bulb should be covered with a very thin, soft fabric. Paint the wick with water which will, naturally, freeze so that it will be necessary to whirl or swing the hygrometer for some time before the lowest wet-bulb reading will be obtained. The most perfect instrument for sub-zero temperature is the SLING PSYCHROMETER.

THE TYCOS HYGRODEIK

The TYCOS HYGRODEIK is a simplified form of Mason's wet-and-dry-bulb hygrometer arranged in such a manner as to render possible the determination of relative and absolute humidity and dewpoint without reference to charts or tables.

The chart placed between the wet and dry bulb tubes is a condensed, graphic presentation of all facts given in hygrometer tables.

The tubes and scales are arranged in two series, one set for temperature readings between 20 and 30 degrees F., the other recording temperatures between 80 and 180 degrees F. Centigrade scales are also available.

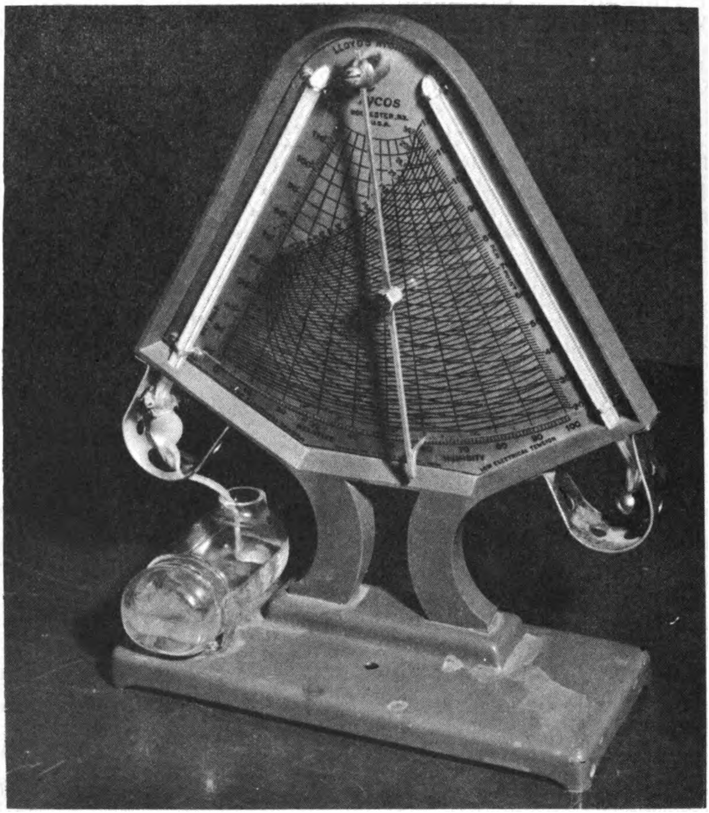


Figure 72. — Tycos Hygrodeik.

An adjustable index swings through the scale from the wet to the dry bulb. The index hand adjustable attached to the swinging arm should be set to the degree line at the left of the chart corresponding to the reading of the wet bulb. The dry bulb reading should then be noted and the curved line followed across the scale to the degree corresponding to the dry bulb reading. The swinging arm is then brought toward the dry bulb thermometer until the index intersects the line coming from the dry bulb. At this point, the relative humidity will be given on the scale at the bottom of the chart. To determine the dewpoint, observe the line running from the top downward to the right.

When extreme accuracy with fixed position hygrometers is desired, the instrument must be vigorously fanned until wet-bulb reading no longer goes down. This will require an additional minute. The Tycos Hygrodeik is shown in figure 72.

Relative humidity is the amount of moisture contained in a given volume divided by the amount which would be present under a condition of saturation.

Dewpoint is the temperature at which visible drops of moisture begin to appear.

Depression of the dewpoint is the number of degrees the dewpoint is below the air temperature.

Hygroscopic denotes having the property or quality of absorbing moisture from the atmosphere.

TYCOS SLING PSYCHROMETER

The sling psychrometer consists of a pair of thermometers mounted in a metal frame to the top of which is fitted a handle which permits the instrument to be rapidly whirled. The lower tube is the "wet bulb" thermometer, the bulb being covered with a fine gauze moistened with clean room-temperature water before an observation is made.

The thermometer must be whirled for about 20 seconds before a reading is made. The operation is repeated until two consecutive readings have been taken, and the two readings agree. The wet bulb reading should always be taken first. Subtract the dry bulb reading from that of the wet bulb to find the depression. Using barometer readings and depression as a guide, refer to the chart book to compute the relative humidity. The Tycos sling psychrometer is illustrated in figure 73.

HYGRO-THERMOGRAPH

The HYGRO-THERMOGRAPH is a standard recording instrument providing a simultaneous weekly record of air temperature and relative humidity on a single instrument chart. The record chart covers a period of one week, usually from 0800 on Monday to 0800 the following Monday.

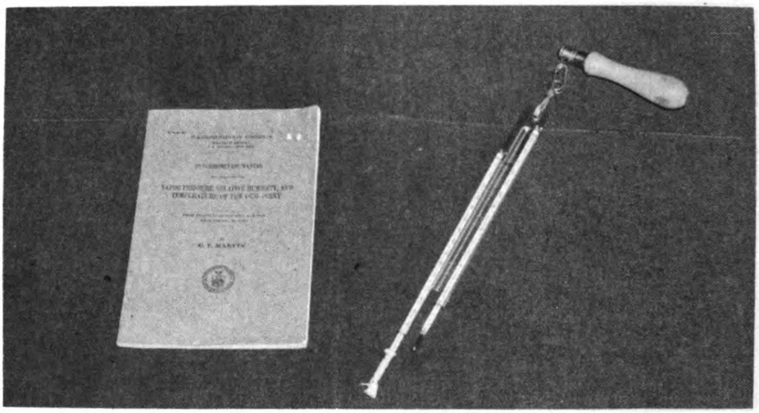


Figure 73. — Tycos sling psychrometer.

Within the cover of this instrument is a chart cylinder and clock assembly which drives the cylinder.

The points of two pen arms, one for temperature and the other for humidity, fit against the chart cylinder. The temperature pen arm is connected to a bourbon tube by linkage. Two sections of either copper or steel riveted together comprise the bourbon tube. With temperature changes, the copper expands or contracts faster than the steel, causing the unit to bend and creating movement of the pen arm through the linkage.

The human hair element is secured at the lower end to a pivoted clamp to permit adjustment. The upper end is attached to the linkage holding the humidity pen arm at its opposite end. Humidity changes cause the hair element to expand and contract, causing movement of the pen arm through the linkage. The points of the pen arms are linked.

The combined actions of the chart cylinder rotation and pen arms movement make inked impressions on chart paper to compile the temperature and humidity record.

For accurate recordings, the instrument should be mounted on a pedestal, protected from drafts and direct heat (such as light bulbs), and near the center of the compartment.

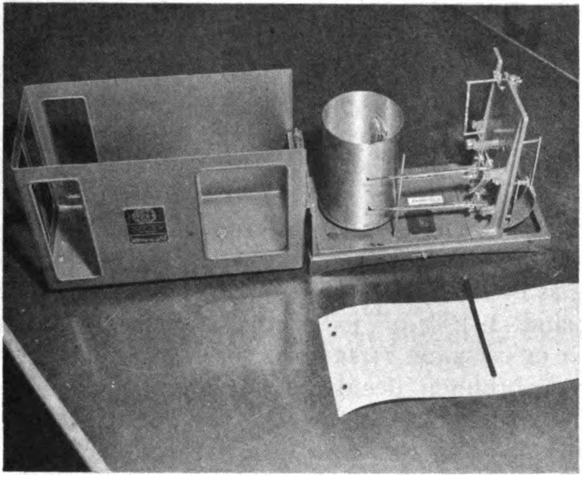


Figure 74. — Hygro-Thermograph.

EXPLANATION OF FAHRENHEIT AND CENTIGRADE SCALES

TEMPERATURE is a measurement of the conditions of heat or cold. The instrument used to measure temperature is called a THERMOMETER.

There are two types of thermometer scales — the FAHRENHEIT used in the English system, and the CENTIGRADE using the metric system. Two standard reference temperatures are used in marking a thermometer into degrees — the freezing point and the boiling point of water. The meaning of a degree of temperature change is best understood from a description of the method of making and grading a mercury thermometer.

In the CENTIGRADE THERMOMETER, a bulb is blown at one end of a piece of thick-walled glass tubing of small uniform bore. The bulb and tube are then filled with mercury at a temperature slightly above the highest recording to be registered, and the tube is sealed off in a hot flame. As the mercury cools, it contracts and falls away from the top of the tube, leaving a vacuum above it.

The bulb is then surrounded with melting ice or snow, and the point at which the mercury stands in the tube is marked 0. Then the instrument is placed in steam rising from BOILING WATER at normal barometric pressure, and the new position of the mercury is marked 100. The space between these markings is then divided into 100 equal parts called DEGREES, and divisions of the same length are extended above the 100-degree mark and below the point of 0 degree. One degree of temperature change measured on such a thermometer is the change which will cause the mercury in the stem to move past one of the graduations — that is, such a temperature change as will cause the mercury contained in a glass tube to expand 1/100 of its volume. Such instrument is called a CENTIGRADE THERMOMETER.

Why Fahrenheit decided to divide the space between the freezing and boiling points of water into 180 degrees is not clear. On this scale, the freezing point is set at 32° and the boiling point at 212°.

Today, the centigrade scale is used in all laboratories since it is more convenient to use than the Fahrenheit scale.

CONVERSION, DEGREES, AND TEMPERATURE EQUIVALENT

From the methods of graduation of the Fahrenheit and centigrade thermometers, it can be seen that 100 degrees on the centigrade scale denotes the same difference of temperature as 180 degrees on the Fahrenheit scale. Hence, ONE DEGREE FAHRENHEIT EQUALS FIVE-NINTHS OF ONE DEGREE CENTIGRADE, and conversely, ONE DEGREE CENTIGRADE EQUALS NINE-FIFTHS OF A FAHRENHEIT DEGREE.

To convert from the Fahrenheit to the centigrade scale, first determine the number of Fahrenheit degrees the given temperature is above or below the freezing point

(32 degrees Fahrenheit), and then multiply by 5/9. To convert from centigrade to Fahrenheit, first multiply by 9/5 in order to find the number of Fahrenheit degrees the given temperature is above or below the freezing point.

There are 32 degrees Fahrenheit on the Fahrenheit thermometer before the freezing point is reached and zero degrees on the Centigrade thermometer. The ratio existing between Fahrenheit degrees and centigrade degrees is 180 to 100, or 180/100. Hence, $\frac{F-32}{C}$ equals $\frac{180}{100}$.

Therefore, to change centigrade to Fahrenheit, multiply by 9/5 and add 32 to the product. To convert Fahrenheit to centigrade, subtract 32 from the Fahrenheit reading and multiply by 5/9.

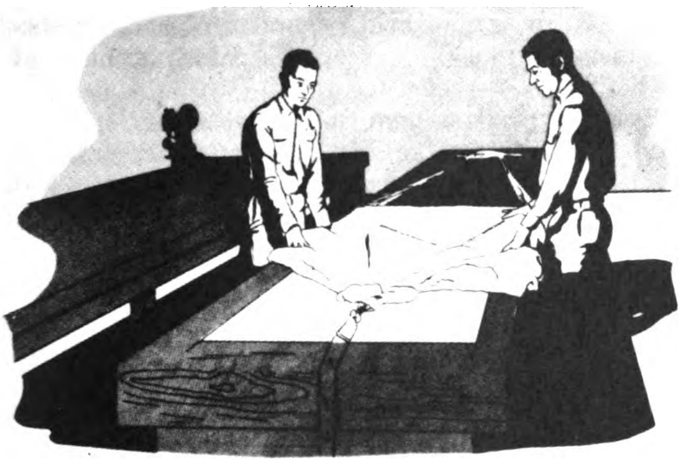
QUIZ

1. When a parachute is hung in the dry locker, it is suspended
   - *a.* by its periphery.
   - *b.* by its shroud lines.
   - *c.* by its harness.
   - *d.* by its peak.
2. The ideal temperature for a parachute storeroom is
   - *a.* 65 degrees.
   - *b.* 74 degrees.
   - *c.* 85 degrees.
   - *d.* 120 degrees.
3. In a parachute storeroom, what condition, closely related to temperature, must be controlled?
4. How high above the deck should the lowest row of storage bins be?
5. How long should a parachute hang in the dry locker?
6. What is the capacity of a portable dry locker approximately 20 feet square?

7. What is the most common width of fabric used in parachutes?

8. What is the daily dry locker capacity of a two-table loft?

9. What are the two most common types of thermometer scales?



CHAPTER 6

INSPECTION

WHAT IT IS

What does a thorough and complete parachute inspection entail? The answer is simple — in fact, but one answer exists. Where lifesaving devices such as parachutes are concerned, no choice of methods as regards their care is offered.

PARACHUTE INSPECTION MUST BE CONDUCTED TO THE FINEST DEGREE DEEMED NECESSARY TO INSURE COMFORT, SECURITY, RAPID POSITIVE FUNCTIONING, AND AIR WORTHINESS OF THE ENTIRE ASSEMBLY.

Let us consider that last statement. Firstly, the inspection must insure COMFORT. Just what does this requirement imply? All pilots and plane crewmen are required by regulations to wear parachutes or parachute harnesses continuously while in flight. An improperly adjusted or poorly rigged assembly is a major factor in the development of fatigue and consequent relaxed vigilance.

SECURITY. This means that the various sub-assemblies of a parachute must be securely rigged so that one part will not break or tear away from another and thus jeopardize the entire unit. At the moment of opening shock it is imperative that the wearer of a parachute be secure in his harness.

By RAPID POSITIVE FUNCTIONING we meant exactly what the term implies. Trouble does not respect altitude; an engine or any other functional aircraft part is fully as liable to "act up" at 100 feet as at 10,000 feet, requiring the crew to "hit the silk." At low altitudes, a rapid positive functioning of the assembly is of paramount importance.

AIRWORTHINESS. Last of all, CAN THE PARACHUTE TAKE IT? Will it stand up under all service conditions, particularly at the crucial moment of opening shock? That is the vital question, and the answer depends on the Parachute Rigger.

If, upon completion of a service parachute inspection, all the above considerations can be affirmatively answered, you have carried out a task worthy of your calling — you have made a GOOD inspection.

From what has been said, it may be gathered that a detailed and painstaking inspection is definitely imperative, and that is exactly the case. But the TIME ELEMENT must also be considered. Parachute lofts, carrying workloads of chutes running into thousands per month, must operate on a close and fast schedule.

In this chapter we shall trace the inspection of the life of a parachute from infancy in the factory to old age and final decline into aviators' scarfs and cargo chutes.

WHAT TO LOOK FOR

Before you inspect a parachute, you must know *what to look for.* Even though you are familiar with parachute construction, you may not find structural flaws and other details that cause malfunction unless you look specifically for certain imperfections. What are these imperfections?

First of all, let's deliberately look for trouble by respectively reviewing the five major parts of a parachute —

pilot chute, canopy, shroud lines, harness, and container (including accessories). We will consider separately each Navy standard parachute, despite the fact that the trouble pattern is similar for all chutes.

Parachute trouble may be summed up under the following factors — (1) wear, (2) deterioration, (3) stains, (4) non-continuity, (5) non-compliance with technical publications, (6) incompleteness, (7) manufacturers' errors, and (8) flaws.

These common causes of failure are more or less constantly present, threatening the service life and positive functioning of the parachute. Upon the Parachute Rigger depends the detection of these potential ailments and the remedying of such flaws before a parachute is issued for service. Through constant and relentless inspection, these trouble factors may be held to a minimum.

Upon first view of the above list of trouble factors, one might well deem the list superfluous, believing that several of the causes of trouble have similar meanings. Such is not the case — there is as great a difference between WEAR and DETERIORATION as between black and white. During each inspection, all eight factors must be kept constantly in mind.

WEAR

When you think of wear, the most destructive of the eight factors, you think of chafing, tears, burns, and bent and broken assemblies. In such estimate you are entirely correct. An example of common wear is shown in figure 75.

DETERIORATION

Look for areas which may come in contact with harmful foreign substances such as oil, acids, salt water, and ammonia. Stains are a common indication of deterioration, but it must be pointed out that acid stains are not easily detected.

Recognition of stains calls for an eagle eye, as deterioration is very often confused with wear. A slightly worn and chafed area may be passed over, whereas evidence of the first sign of deterioration may never be overlooked, but must be immediately corrected. Figure 76 illustrates an example of deterioration.

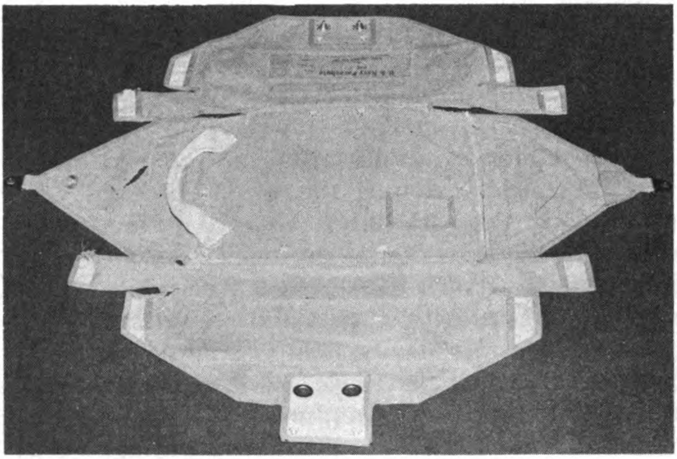


Figure 75. — Badly worn pack.

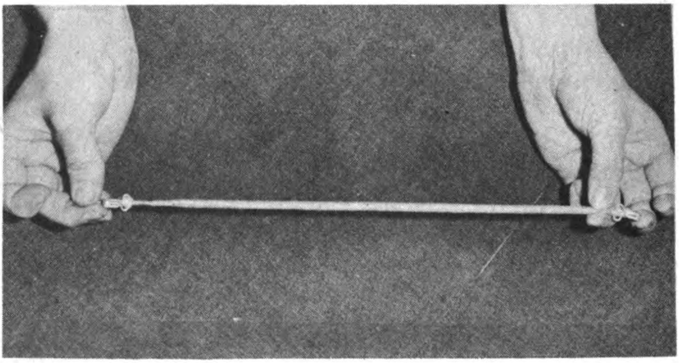


Figure 76. — Deteriorated pack-opening elastic.

STAINS

Remember always that every stain is a potential threat of deterioration. Stains should be tested by application of litmus paper for evidence of harmful acids or alkalies.

NON-CONTINUITY

Is each unit of the assembly in proper position? Are all shroud lines in correct rotation at the links, or are they lost in a maze of dips and twists?

NON-COMPLIANCE WITH TECHNICAL PUBLICATIONS

Is the parachute up-to-date? Have all the latest modifications and improvements been incorporated into the design?

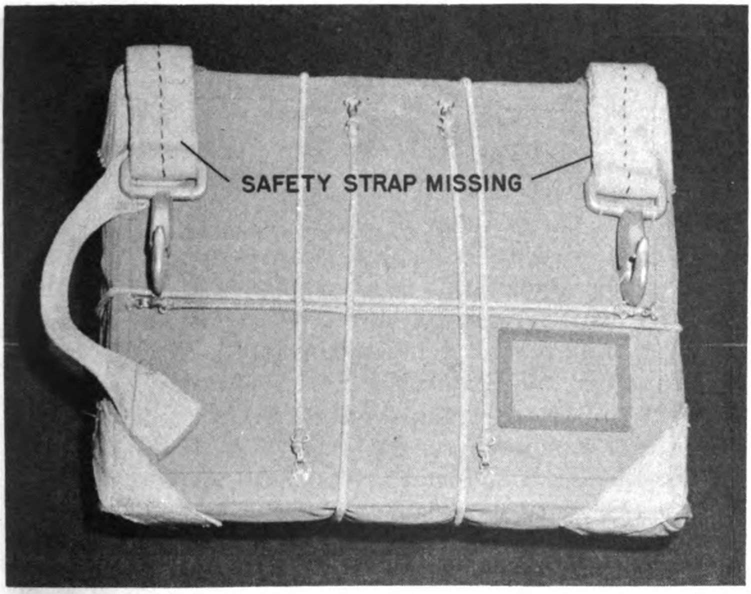


Figure 77. — Incompleteness can cause failure.

INCOMPLETENESS

Is the parachute complete? Regardless of how small and seemingly insignificant a missing item may appear, it is always possible that its omission will affect the rigging process later on. An incomplete assembly may easily cause serious failure. Figure 77 shows a QAC parachute minus a "safety strap" a serious case of incompleteness discovered by a rigger.

MANUFACTURING ERRORS

Mass production is an essential part of the American way of life, but occasionally slip-ups occur and things get by unnoticed. There are times when improperly rigged parachutes slip by inspectors all along the line from factory to loft.

Simply because something is new is no indication of perfection. The SECURITY of all sewings and tackings must be scrutinized. You will occasionally come across a new chute with the shroud lines secured to the links out of rotation, or a hand-pull pocket may be secured in wrong position to the harness. Or you may find a harness with a twist which may be removed only by replacing the sewing.

FLAWS

Small material imperfections may, if ignored, cause the failure of an entire unit.

Material used in parachute construction is normally made in one grade only — the very best grade obtainable. Material made to FEDERAL and AN SPECIFICATIONS is subjected to innumerable tests and inspections. During the process of making a chute, the fabrics, webbing, tapes, and so forth, are closely scrutinized many times. When you requisition a new chute, the chances of finding serious flaws in the cloth or metal sub-assemblies are very slight. Yet the chance of such flaw existing is always present.

When in doubt as to the seriousness of a discovered flaw, consult someone in authority or turn the assembly in to the nearest supply depot. The only TRUE way of testing webbing or cloth for weaknes is to BREAK the material on a machine. In figure 78, in which several types of flaws found in fabrics are illustrated, (A) shows filling floats of loose silk; (B), filling floats of nylon, and (C), nylon broken picks.

ACCORDING TO SPECIFICATIONS

Like other precise instruments, the life of a parachute begins on a drawing board. Numerous manufacturing drawings and material specifications are forerunners of the finished product. If each of the drawings and applicable specifications were haphazardly followed, the resultant product might resemble anything except a parachute. Manufacturers under Navy contract for parachute production are required to submit to "spot inspection" of their product by specially assigned Navy technicians and inspectors. The Government is thus assured of a superior product. You will probably be interested in looking at the latest Army-Navy Aeronautical Specification for parachutes.

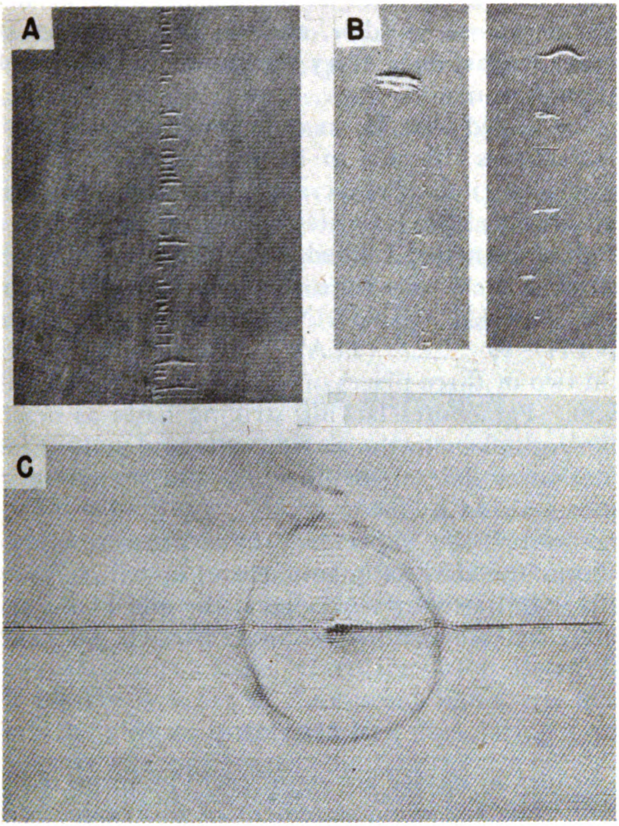


Figure 78. — Flaws in fabrics.

IN STORES

After manufacture, completed parachute assemblies are shipped to various Naval Supply Depots for further distribution.

While in storage, parachutes are given a thorough inspection every 30 days to detect the presence of insects, rodents, dampness, mildew, and so forth, and are aired and dried at least once every six months regardless of apparent condition.

During World War II, in order to permit shipment of new parachutes directly to forward areas in the latest type packages, manufacturers stamped the final striking date on all new gear. Chutes with no striking date must be properly stenciled immediately prior to being placed in service. Each parachute shall be stenciled with the wording: FINAL STRIKING DATE .... (MONTH) 19.............. (YEAR). This wording is stenciled in two or three places on the canopy with stencil ink AN-F-39. Parachutes lacking striking dates as described shall be turned in to the nearest overhaul station for determination of date of manufacture and stenciling in accordance with ACL 76-45.

The normal life expectancy of a parachute is seven years from the date of manufacture, at which time the chute is withdrawn from service at the end of the month indicated on the canopy as the "FINAL STRIKING DATE."

IN SERVICE

Parachutes in service are required to be inspected every 30 days. The following statement of this policy is taken from the Bureau of Aeronautics Parachute Manual:

"ALL PARACHUTES IN ACTIVE SERVICE SHALL BE UNPACKED, AIR-DRIED, INSPECTED, AND REPACKED AT LEAST ONCE EVERY THIRTY DAYS."

To permit a parachute to remain packed longer will cause the canopy to wrinkle and lose resiliency, a vital quality essential to rapid and positive opening. Notice the words: "AT LEAST ONCE EVERY THIRTY DAYS." Parachutes subjected to warm and humid climates shall be inspected for the presence of fungus growth, and so forth, and repacked each 15 days or oftener, depending upon actual field conditions.

SURVEY

Upon completion of seven years of service, parachutes are turned in to a major repair station for survey and eventual removal from the records. Such surveyed chutes may later be converted into aviators scarfs or cargo chutes.

Parachutes cannot be surveyed by aviation units unless LOST OR DESTROYED, and chutes damaged or deteriorated beyond reconditioning shall be returned to a major repair station. A Parachute Rigger may only RECOMMEND a survey; the actual survey is made by a SURVEY BOARD.

DETAILED SERVICE INSPECTION

An ordinary packing table 40 feet in length, three feet wide, and 36 inches high is all that is required for proper parachute inspection. Major overhaul stations generally use specially-constructed inspection tables where great numbers of new and repaired parachutes are inspected.

The frosted-glass inspection table is that most generally used by manufacturers and major overhaul stations. The frosted glass covers a large percentage of the upper portion of the table. A series of fluorescent lights are arranged beneath the glass to throw an even, non-glaring illumination up through the canopy, enabling the tracing of every stitch of sewing to ascertain the security of all seams and hems.

For field inspection, an ordinary packing table is quite adequate for carrying out a good parachute inspection. The illuminated type canopy inspection table is illustrated in figure 79.

INSPECTION PROCEDURE

Dust the table, making certain that it is perfectly clean. Lay the chute out so that the apex is toward the head of the table. Secure the apex and remove any possible dips and twists, then fasten the chute under tension and begin the inspection.

Inspect each of the five major parts of the parachute in sequence and all sub-assemblies of each part, beginning with the pilot chute and working down to the pack, or vice versa.

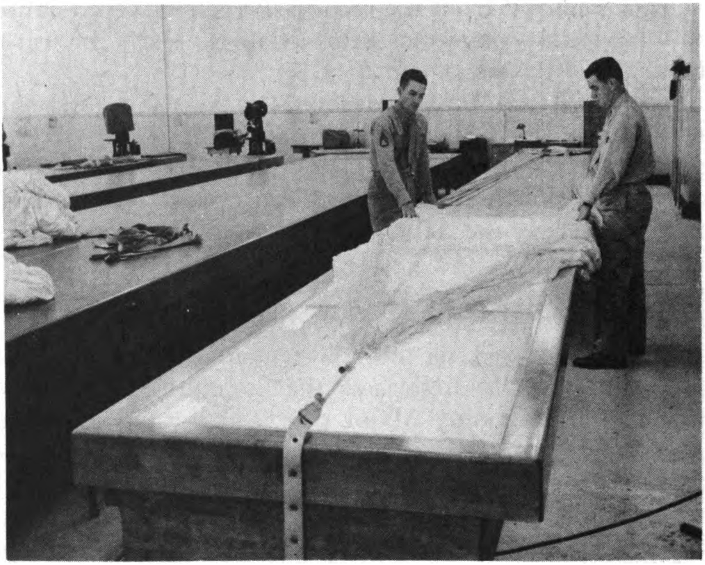


Figure 79.—Illuminated canopy inspection table.

Regardless of the general apparent condition of the parachute, it must be thoroughly inspected. The time required to examine a complete parachute varies with the age and condition of the gear, but the time devoted is of secondary consideration when it is borne in mind that lives depend upon close and conscientious work.

If a part or section is worn, deteriorated, stained, or contains a flaw, the only remedy is repair or removal of the entire affected area or section. In the event an assembly contains some type of twist or similar defect, or if lack of continuity exists because of a manufacturing error, try to correct the trouble. Should this prove impossible, replacement of the defective part is the complete remedy. If some part of the assembly is missing, a reliable inspection is impossible. Find the missing part.

If the assembly is not up-to-date and is lacking some recent modification, the only remedy is to bring it up to date by consulting applicable technical publications.

PILOT CHUTES

Inspect the pilot chute for spring tension and determine that all parts are unbroken, properly in place, straight, and in perfect working order. In figure 80, an inspector is shown checking the action of a pilot chute. In performing this operation, the inspector compresses the frame and quickly releases it, noting its opening action. In this inspection, make certain that the spring spacer is undamaged, as impairment may affect action of the springs.

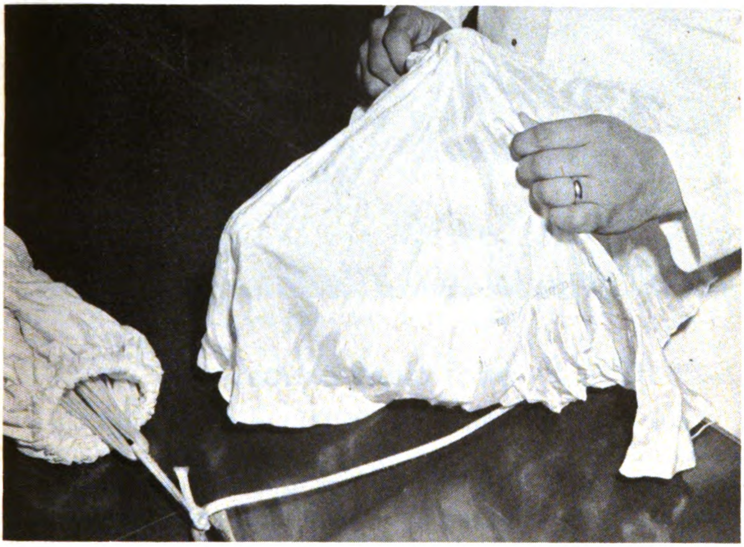


Figure 80.—Checking action of a pilot chute.

Figure 81 shows a pilot chute frame listed as Naval Aircraft Factory STANDARD DRAWINGS INDEX SHEET, NO. 1055, SHEET NO. 1, REVISION 15, DATED 12-2-46. The pilot chute frame number is AAF046209.

There are currently in service several types and variations of pilot chutes, harness packs, rip-cord assemblies, and so forth, and it is felt that a brief generalized explanation of each part being inspected will suffice for our discussion. The pilot chute is an example of the past lack of standardization, since there are three different pilot chutes which may be used with any one parachute.

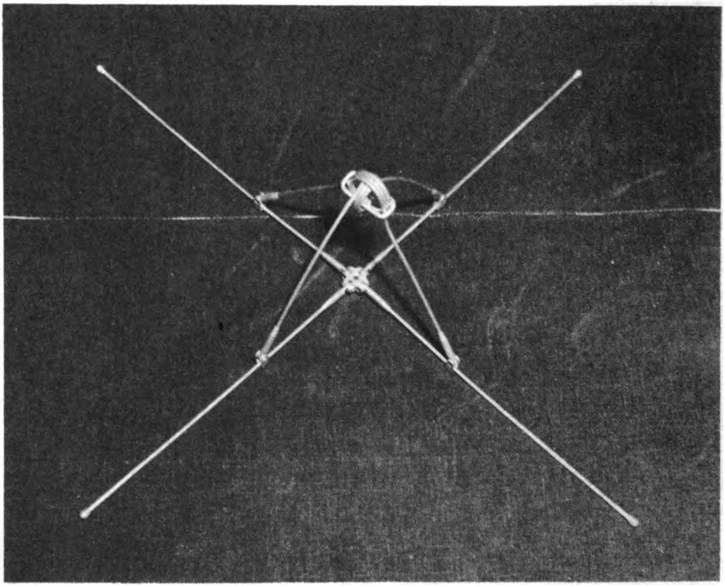


Figure 81. — Pilot chute frame.

PILOT CHUTE CANOPY

Look for tears, punctures, ruptured seams, and chafed areas in the cloth. One of the most common damages is the puncturing of RIB POCKETS and canopy by the ribs of the frame. A canopy of a pilot chute disengaged from the frame and ready for repairs is shown in figure 82.

PILOT CHUTE SUSPENSION LINES

Examine the lines for deterioration and other defects, following the procedure outlined for the main canopy suspension lines. Check the attachment of the lines to the canopy and examine the loop serving or alternate zigzag stitching for security and condition of lines at that point. Figure 83 illustrates a damaged line requiring replacement.

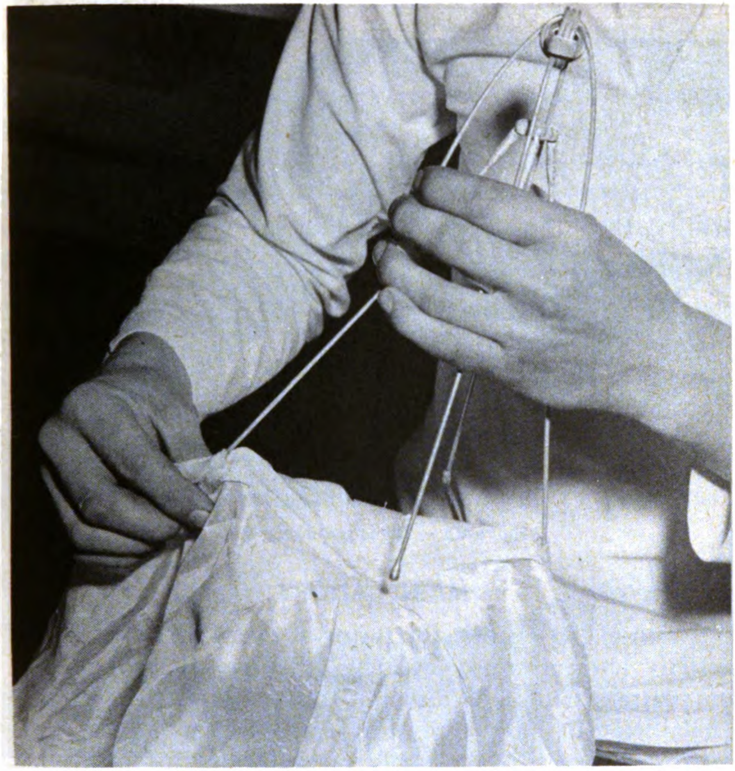


Figure 82.— Removing pilot chute frame.

PILOT CHUTE CONNECTOR CORD

Examine the cord for wear, deterioration, and other defects. Check the tied-off length, which should measure 21½ inches, and the bowline knots for security. At least 1 inch of waxed, bitter end should extend from each knot.

By virtue of its position in the pack the pilot chute is easily soiled and is subject to wear since it bears on the container. If improperly stowed, this unit may well damage the main canopy. A pilot chute used on SS and QAS design parachutes requires more frequent replacement than other types. This is true because the wearer's weight is placed fully upon the assembly during most of each flight.

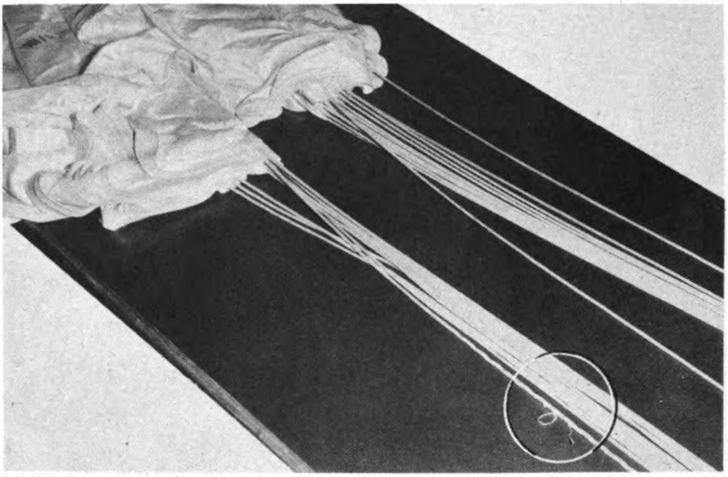


Figure 83.— Damaged shroud line.

MAIN CANOPY

Examine the canopy for stains of every sort that might lead to deterioration. Mildew or rust will weaken silk, and battery acid will discolor this material to a yellow-brown tinge. The important thing to remember upon detecting a stain is to test it for acid or alkaline properties. Litmus paper is generally used for making this test.

Blue and red litmus paper is available in vials and may be ordered through standard stock. To use litmus paper, dampen the affected area with distilled water and alternately touch a strip of blue and red paper to the treated spot and observe the area for possible color change. IF THE BLUE LITMUS TURNS RED, acid is present, and IF THE RED LITMUS TURNS BLUE, an alkaline condition has been detected. If no change in color occurs, the area may be repaired by patching. Figure 84 shows a stain being tested for acid content.

Examine the entire body of the canopy, especially the seams, for damaged or weak spots. One or two slight displacements of the weave are not serious defects, provided the strands are not widely separated or broken. Never attempt to test the strength of the material between your fingers. When in doubt as to the serviceability of a parachute, turn the unit into a major overhaul station. In figure 85, a Parachute Rigger is shown making a separate check of each canopy gore.

Check carefully for holes and tears, and examine the shroud lines for burns caused by friction or rapid openings. Burned panels must be patched or replaced, depending upon the area affected.

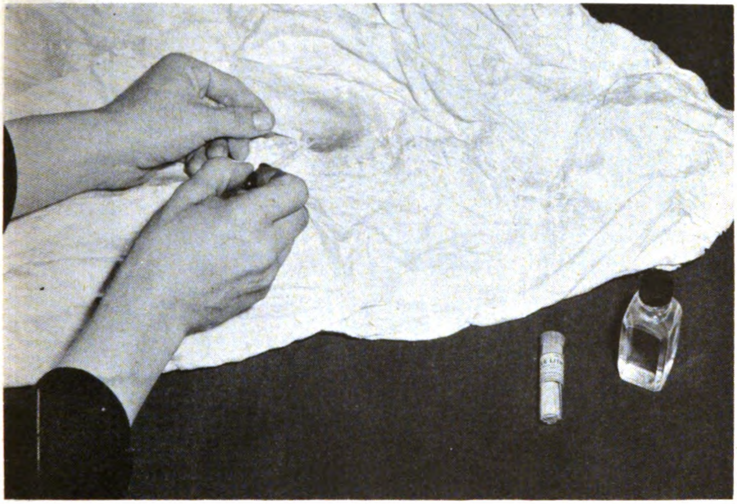


Figure 84. — Testing for acid.

Examine the canopy for evidence of chafing and failure of the seams. Look for broken stitches and enlargement of the outer row of needle-holes when the cloth is subjected to slight tension — not, however, with the fingers. An example of a badly-ruptured seam is shown in figure 86.

Examine the points of the zigzag stitching for security, and check the shroud lines and skirt reinforcements.

Check the vent elastic for strength and resiliency by stretching it to its full width. Examine the vent collar for security.

The proper method for stretch-checking the vent rubber is shown in figure 87.

Observe the striking date as shown in figure 88. This information is stamped on the canopy in at least two places. Check the Navy canopy serial number required to appear on the pack. The striking date should also appear on the PACKING DATA CARD.

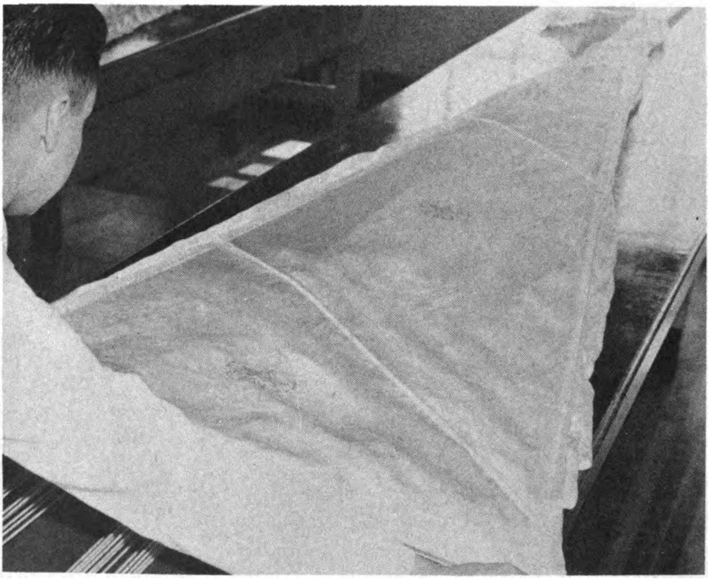


Figure 85. — Gore inspection.

The peak of the canopy is the section most frequently soiled, because it is the outermost area of the pack. Sections of the canopy protruding from the pack are very likely to contain oil and acid stains.

Parachute canopies used in conjunction with SS and QAS designs retain creases longer and require a greater amount of shaking-out prior to airing and drying. Dirt and weak spots will appear in creases or folds which have been neglected.

SHROUD LINES

Examine shroud lines for evidence of fraying. Such signs are indicated by snagged places and thread ends projecting from the braided casing.

Check the cords for breaks, burns, and cuts caused by friction of opening. Friction burns on nylon cause stiffening and fusing of the strands. Cords showing evidence of burns should be replaced.

Examine the cords for rust or chafing at points where the lines are secured to the connector links, and inspect the attachment of lines to the connector links for proper security and unison.

SHROUD LINES ARE ONE OF THE MAINSTAYS OF THE ENTIRE PARACHUTE ASSEMBLY. They form the frame, or network, for the canopy cloth, and join the canopy to the links and the harness.

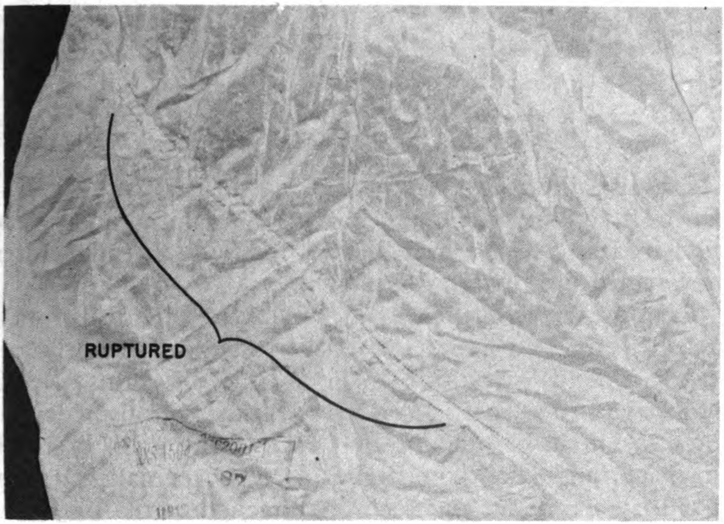


Figure 86. — Ruptured seam.

Superficial snags in the outer covering of the cordage may be disregarded, but when the inner cords are severed and may be seen protruding through the braid, replacement of the shroud is the sole remedy.

Wear and tear on suspension lines is almost the same for all parachutes in a packed condition and having the same number of hesitator loops.

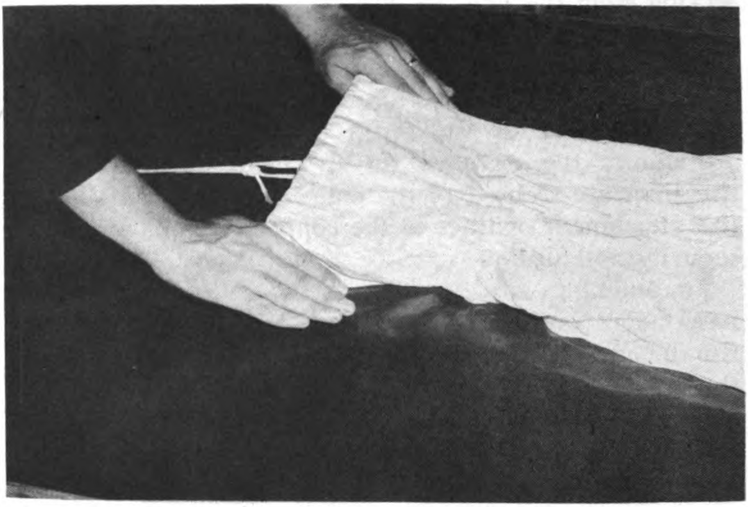


Figure 87. — Checking vent-rubber elasticity.

PACK

Examine the pack for rips and fabric tears and for evidence of chafing where the fabric comes in contact with the wire frame of the pack. Look for loose threads which may retard the opening of the chute.

Examine for acid burns and, if detected, neutralize the area or renew the pack. Check the canopy carefully for traces of acid. Examine for rust and oil stains which may have progressed to the cloth of the canopy; inspect the attachment of side and end flaps to the main body of the pack, and check the hesitator loops to make certain that they are intact and securely attached to the pack.

Check the wire frame for damage by feeling through the exterior of the pack. Examine the stiffeners for construction and for evidence of chafing of the fabric enclosing them. Examine the security and attachment of the pack to the harness, and check the eyes for security of attachment to the pack.

GROMMETS, END TABS, AND LOCKING CONES

Inspect for missing, damaged, or unserviceable grommets, and make certain that grommets have been perfectly and properly set. Check end tabs for proper shape and smoothness, tolerating no burrs, and examine the locking cones for security, position, rough places, cracks, and sharp corners. The surface of the conical portion and locking-pin holes must be perfectly smooth.

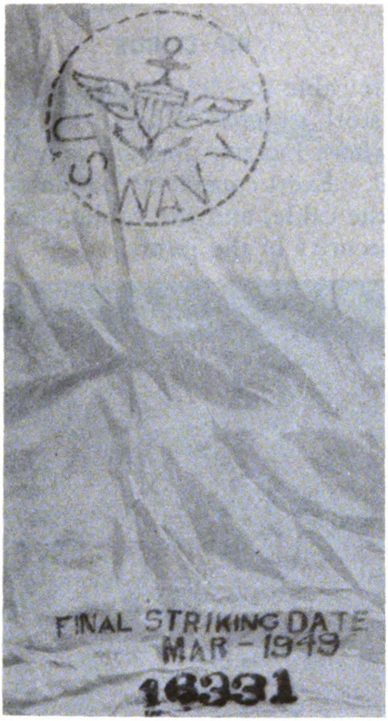


Figure 88. — Striking date.

Examine flap-removing elastics for chafed or broken places, ruptured elastic members, acid burns, and for age. The flap-removing elastics should be removed at regular intervals, and replaced. Check the latest applicable technical publications for information concerning age limits.

Check the hooks for condition and security of attachment to the ends of the elastic cord. The pack is the most abused part of the parachute, and requires more frequent renewal than any other major part. Seat-type packs are more liable to rust, oil, and acid stains than any other type.

The side tackings of packs employing retainer or belly straps should be closely checked for security, and the frames for distortion.

RIP CORDS

Examine the cable for defects such as rust spots, kinks, and broken steel strands. Check the joints of swaged connections where locking pins are attached to the cable and hand pull. Exert considerable manual force between the pin and the cable, and the cable and the grip, to determine the security of the joints.

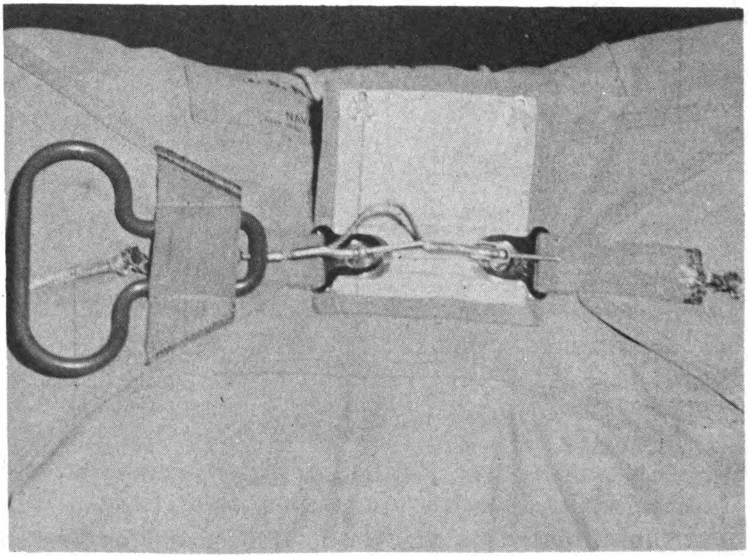


Figure 89. — Improper pin spacing.

Rip cord grips having painted finish should be examined to insure that the paint has not softened causing the grips to stick to the pocket.

Examine for bent, cracked, rusted, or rough locking pins. Check the rip cord pin spacing in the pack locking cones. The pins should set completely through the cones without bending the cable and without showing evidence of shorter spacing. Improper spacing of pin and cone is shown in figure 89.

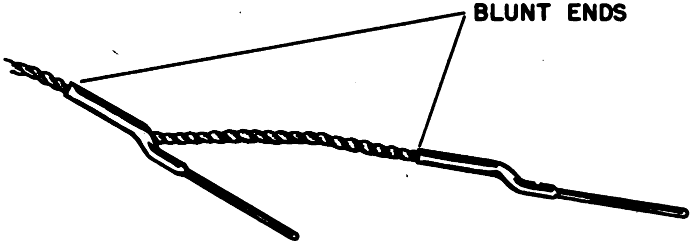


Figure 90. — Blunt end pins.

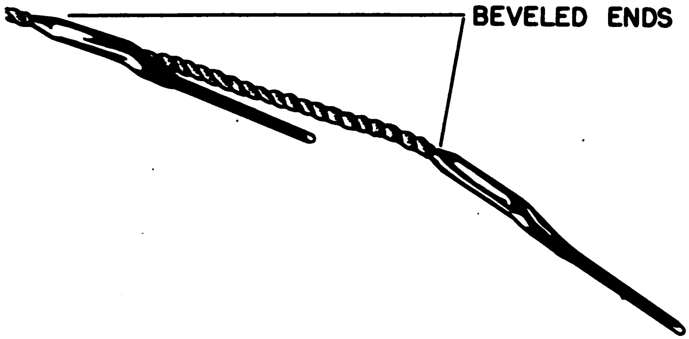


Figure 91. — Properly "beveled end" locking pins.

Examine the swaged rip cord pins having blunt shoulder-ends (illustrated in figure 90) as they have a tendency to jam against the end of certain rip cord housings and thus make rip-cord pulling difficult. These pins must be replaced with properly "beveled end" locking pin rip-cord assemblies, as shown in figure 91.

Examine the hand pull for excessive wear at the cable connection. When a rip cord is in place on the parachute, the pull required to "crack" the chute must not exceed 22 pounds.

Rip-cord assemblies used on seat-type parachutes are more frequently damaged than those used on other types.

RIP-CORD HOUSING

Check the rip-cord housing for rust, permanent bends or kinks, breaks, and condition of ferrules at each end. Figure 92 shows an example of a badly scarred housing ferrule. The type shown here, however, is not the latest design.

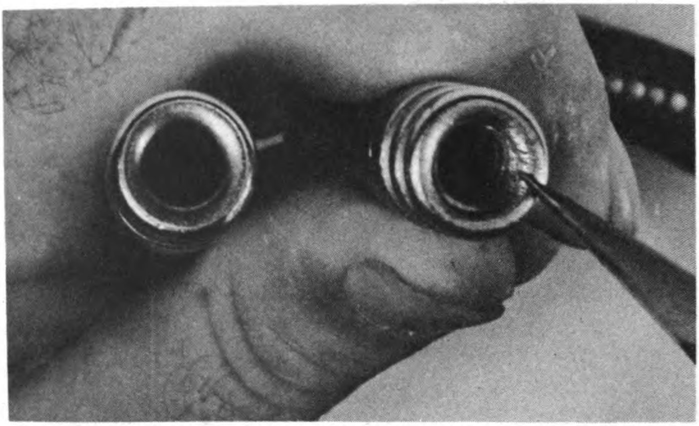


Figure 92. — Scarred housing ferrule on old-type housing.

Examine the housing for security of tackings and proper passage around the webbing, making certain that the housing is sufficiently long and that it properly protects the rip-cord cable. Improperly adjusted housing can cause serious trouble.

HAND PULL POCKETS

Inspect the sewing and tacking for security, and check carefully for signs of deterioration and wear. The pocket must hold the hand pull securely while permitting it to protrude sufficiently to be instantly accessible to even a heavily-gloved hand. Any pocket allowing the hand pull to easily dislodge, or which is so tight as to make withdrawal difficult, must be replaced.

The fabric and elastic pockets used with the trapezoid hand pulls usually tear out in the inside corners. Trapezoid hand pulls and pockets are used on SS, SB, and TB design parachutes.

HARNESS AND LIFT WEB ASSEMBLIES

The webbing must be examined for weak spots which may be caused by acid burns, mold, or rust. Acid generally shows up white or black on the harness. The examination should include the webbing under metal fittings, since rust and mold are often found in these locations.

Examine the webbing for evidence of chaffing or failure at the load points, and check for proper attachment of lift webs to connector links. THIS IS AN EXTREMELY VITAL ATTACHMENT.

Inspect for proper attachment of harness to pack on fixed-type parachutes. Inspect for broken stitches where two straps of webbing intersect and are secured by sewing, or where one strap of webbing terminates at another strap and is secured by sewing.

Examine for broken stitches at all points where hardware is attached, and check all harness hardware adapters, "V" rings, snap hooks, and so forth, for breaks, cracks, bends, and corrosion.

Check the springs in snap hooks for tension and operation.

Friction hardware must work freely and contain no burrs.

Examine for proper assembly of harness to hardware.

Army-Navy type harnesses or any other models employing a short, straight chest strap must be checked for the presence of a shoulder-strap retainer.

There is a tendency in the inspection of quick-attachable assemblies (QAC and QAS) to skip the harness because it is stowed separately from the remainder of the unit.

A system should be set up whereby the harness may be inspected along with the rest of the parachute.

Harnesses are replaced at the discretion of the Parachute Rigger, and should never be in service more than 7 years.

SEAT CUSHION

Examine for security, wear, and deterioration. Check corners where tackings are made for signs of fraying.

BACK PAD

Check for security, and examine tackings for proper use of cords and threads. Back pads used on quick-fit designs are not tacked to the harness. Examine the webbing keepers and fasteners, replacing all defective keepers.

PARARAFT KIT CONTAINER

Inspect for position and security to the parachute pack. Check quick-releasing device for positive and smooth operation. Inspection of the pararaft is an entirely separate operation, and is treated in detail in another book devoted to that unit.

Figure 93 illustrates one type of PARACHUTE INSPECTION FORM which will greatly aid you in conducting an inspection.

DISPOSITIONING PARACHUTES

There may be occasions during the course of an inspection when you will find it difficult to disposition a parachute properly according to a previously set pattern. In any event, when doubt exists as to SERVICEABILITY, you will understand the procedure to follow. When a parachute is "turned in", a REPORT should be attached, detailing the repairs required or other applicable explanation so as to expedite return of the chute to service.

INSPECTION REPORT

Parachute No. ------------- Date ---------------------

Inspector ---------------------------

PART	O.K.	REATTACH	REPAIR	REPLACE	REMARKS
A. HARNESS:					
Hand-pull pocket					
Rip-cord housing					
Rip cord					
Webbing and attachment					
Hardware					
Back pad					
B. CONTAINER:					
Cushion					
Hesitator loops					
Flaps & tabs					
Stiffeners					
Pockets					
Grommets					
Cones					
Hooks & eyes					
Elastics					
Frame					
C. SHROUD LINES:					
Zigzag stitching					
Shroud line, link to skirt					
D. CANOPY:					
Silk					
Skirt					
Radial seams					
Zigzag stitching					
Diagonal seams					
Vent collar					
Vent rubber					
E. PILOT CHUTE:					
Pilot chute connector cord					
Silk					
Rib pockets					
Wire frame					
Shroud lines					

Figure 93. — Parachute inspection form.

TRANSFER

Parachutes are not to be transferred from one organization to which assigned to another outfit without authority from the Bureau of Aeronautics.

MAJOR REPAIR

Parachutes requiring major repairs are reported as out of commission and held by the reporting activity pending receipt of shipping instructions. The Navy maintains numerous parachute major overhaul stations capable of effecting such repairs, and a list of such stations is included in the Bureau of Aeronautics Parachute Manual.

QUIZ

1. What is the test for an acid stain on a parachute?
2. How is a parachute laid out on a table for inspection?
3. What is the normal life expectancy of a parachute?
4. What are the major imperfections that you would look for in inspecting a parachute? Which of these is the most destructive?
5. How often are parachutes which are in storage inspected? How often are they aired and dried?
6. What are some of the defects to look for when inspecting a pilot chute canopy?
7. What should be the tied-off length of the pilot chute connector cord?
8. What section of the main canopy is most frequently soiled?
9. How can friction burns on nylon shroud lines be recognized?
10. What part of the parachute is the most abused and requires the most frequent renewal?
11. What is the maximum pull which should be required to crack a chute?

12. What types of parachutes use a trapezoid hand-pull?

13. What is the maximum length of time that parachute harness should remain in service?

14. Who may authorize the transfer of parachutes from one organization to another?

CHAPTER 7

MAINTENANCE AND REPAIRS

BLUEPRINTS

In order to repair parachutes so that they will be as "good as new," the Parachute Rigger must possess a thorough understanding of parachute construction.

There is but one way of acquiring such understanding — by READING AND STUDYING OF NAF BLUEPRINTS. Specifications definitely state just which materials are to be used, where fabrics are to be cut, the manner in which cloth warp and filler is to be arranged, and the types of stitches to be used.

All parachutes in service have been constructed from some series of blueprints, of either NAF, AN, or AAF origin. In repairing a chute, but one result is sought — that of returning the unit to service in perfect condition. To attain this end, retracing of the original manufacturing plans is suggested.

Modern blueprints establish the total length of a cut shroud line as 65 feet, seven inches. At one time the corresponding measurement for the seat-type chute was 57 feet and five inches. This proves the necessity for thorough understanding of the parachute upon which you are working before major repair is attempted.

Technical information, such as TECHNICAL NOTES, TECHNICAL ORDERS, and AVIATION CIRCULAR LETTERS will keep you posted on parachutes. These technical publications are law, and as such are to be faithfully followed.

SEAMS

Stitches, stitching, and seams are to a parachute what nuts, bolts, rivets, and screws are to an airplane.

A STITCH, precisely, is a unit of thread formation in the production of seams and stitching. A SEAM consists of a series of stitches joining two or more plies of material, and STITCHING consists of a series of stitches embodied in the material for finishing an edge or for ornamental purposes, or both.

Seams are classified in three categories — SUPERIMPOSED (SS), LAP (LS), and BINDING (BS), and each class is subdivided into types. The classes of stitchings commonly used in parachute structures are the EDGE FINISHINGS (EF), and ORNAMENTAL STITCHINGS (OS). Stitchings are in turn sub-divided into types, and the stitches are types classified by number.

Symbols are used to specify the type of seam or stitching to be used. For example, you may come in contact with codes such as "301-SSa-1" or "301-OSd-2". These codes are simple to read and understand when you are familiar with the key, explained as follows:

301 SSa 1

1 —number of rows of stitches.

SSa —type of stitch to be used.

301 —type of seam or stitching.

Federal Specification DDD-S-751, entitled *Stitches, Seams, and Stitching* treats the subject very thoroughly, and is recommended for your loft library.

LAYING OUT AND CUTTING MATERIALS

Make certain that all equipment and material is clean, and that scrap pieces of fabric are clear of the deck and readily accessible when needed for patching.

When the required material is properly laid out on the table, use the proper tools — square, yardstick, and so forth — for marking and cutting. Remember, all materials used in parachute repair must be new and of the same quality and pattern as the damaged part. This holds particularly true in the patching of parachute canopies.

MAKING A PARACHUTE CONTAINER

Let's consider the fabrication of a seat-type parachute container. The first step is to consult the drawing and refer to the *Aeronautical Material and Fittings Catalog* for information under its section on NAF STANDARD DRAWINGS. NAF drawings index series 1055, sheet number 1, concern the seat-type parachute regular harness and 24-foot canopy. The drawing number indicated (6-27-47) under *Pack Assy (Without Opening Cords)* is listed as NAF Blueprint 69368-34, parachute pack without opening cords. Included in this chapter is a general drawing of this type parachute (figure 94) along with detail drawings of various sub-assemblies. There are a great number of this type parachute in use today; however, this design is now considered obsolete. These drawings are included merely to acquaint you with a blueprint and to show you how a parachute is constructed.

For reasons of economy the Navy often requires consumption of old stock items before new equipment may be issued. Therefore, you must consider this practice before making changes. For example, the seat-type parachute was at one time rigged with "clover-leaf" design rip-cord hand pulls. During the past two years, however, the Navy has returned to the trapezoid design.

NO.REQ.	ASSEM.	PART NO.	NAME	STOCK	MATERIAL	SPEC.			FINISH	EST.WT.	ACT.WT.
1	69368 32/34	69368-36	CODE-GROUND/AIR EMERGENCY-NAV AER 00-25-513 (SEE NOTE # 11)								
			THREAD 16-4 CORD	100 YDS	COTTON	V-T-276 TY-IB3					
			THREAD-3 CORD	10 YDS	COTTON	AN-T-48 TY II STYLE A-AIRGRAY	SEE	NOTE	1		
8 2 2 8	-33 -10 -9 -3	212257-1	EYE								
2 2	-33 -3	39043-7	STIFFENER								
2 2	-33 -3	AN6560CI	GROMMET & WASHER								
2 2	-33 -3	39043-2	STIFFENER								
1 1	-32 -34	36752-20	FRAME								
1	-5	AN6572-1	FASTENER								
2	-9	311394-1	CONE (SEE NOTE 10)								
2	-34	-35	KEEPER-HARNESS	1 3/4 x 6 3/4	WEBBING	AN-W-21 TYPE VI					
1	69368-32	-33	FLAT PATTERN - SUB ASSY (Q.A.S. TYPE) SEE NOTE 9								
1	600014-1	-32	PACK ASSY - WITHOUT PACK OPENING BANDS (Q.A.S. TYPE) SEE NOTE 9								
1	69368-32	-31	FALSE BOTTOM - SUB ASSY (Q.A.S. TYPE)								
1	-11	-29	FLAP COVER	6 x 2 5/8	COTTON	AN-CCC-F-56					
1	-10	-28	FLAP-RIP CORD PROT.	6 x 7 7/16	COTTON DUCK	CCC-D-771 TY I MED. TEX. #1 WHITE					
1	-9	-27	FLAP-CONE	3 x 6	COTTON	AN-CCC-F-56					
1	-9	-26	STIFFENER-CONE FLAP	3 x 6	COTTON DUCK	CCC-D-771 TY I MED. TEX. #1 WHITE					
1	-8	-25	PILOT CHUTE FLAP	4 1/2 x 12							
1	-7	-24	CORNER FLAP	3 x 7 1/2							
1	-6	-23	POCKET	2 5/8 x 3 5/8	COTTON	AN-CCC-F-56					
1	-5	-22	WEBBING-TAB	1 x 6	COTTON WEBBING	W-44	HERRINGBONE WEAVE NO ALTERNATE ACCEPTABLE				
2	-4	-21	PATCH-FALSE BOTT.	3 3/4 x 8		AN-CCC-F-56					
2 2	-31 -4	-20	TUCK-SHROUD LINE	1 1/2 x 20 1/2		AN-DDD-T-91 TYPE II					
1 1	-31 -4	-19	FALSE BOTTOM	14 1/4 x 16 1/2		AN-CCC-F-56					
AS REQ	-33 -3	-18	TAPE-REINFORC'G	1 x 111		AN-DDD-T-91 TYPE II					
"	AS REQ.	-17	TAPE-BINDING	3/4 x 360		AN-DDD-T-91 TYPE III					
1 1	-33 -3	-16	FLAT PATTERN	32 x 32	COTTON	AN-CCC-F-56	SEE	NOTE	3		
4 4	-33 -3	-15	REENFORC'G CORNER	1 3/4 x 5	COTTON WEBBING	AN-W-21 TYPE VI					
2 2	-33 -3	-14	POCKET-STIFFENER	1 1/2 x 15 1/4							
2 2	-33 -3	-13	POCKET-STIFFENER	1 1/2 x 10		AN-DDD-T-91 TYPE II					
1 1	-33 -3	-12	NAME TAG	2 3/4 x 9 1/4	COTTON	ANCCC-F-56					
1 1	-33 -3	-11	FLAP COVER-SUB-ASSY.								
1 1	-33 -3	-10	RIP CORD PROTECTION FLAP-SUB ASSY								
1 1	-33 -3	-9	CONE FLAP-SUB ASSY.								
2 2	-33 -3	-8	PILOT SHUTE FLAP-SUB ASSY.								
2 2	-33 -3	-7	CORNER FLAP-SUB ASSY.								
1 1 1 1	-33 -31 -4 -3	-6	POCKET-INSPECTION TAG-SUB ASSY.								
2 2	-33 -3	-5	TAB-SUB ASSY.								
1	-34	-4	FALSE BOTTOM	SUB ASSY.							
1	69368-34	-3	FLAT PATTERN-SUB ASSY. (SEAT SERVICE TYPE)								
1 1	600230-3 601473-3	69368-34	PACK ASSY. WITHOUT PACK OPENING BANDS (SEAT SERVICE TYPE)								

- NOTES -

1. ALL MACHINE STITCHING TO BE WITH COTTON THREAD CONFORMING TO SPEC. V-T-276, TYPE IB3, 16-4 AIRCRAFT GRAY. CONES TO BE HAND SEWN AROUND AND OVER EDGE WITH DOUBLE 3-CORD COTTON THREAD WAXED. (CONES MAY BE MACHINE SEWED AT NAF WITH #12-4 CORD COTTON THREAD SPEC. V-T-276, TYPE IB1). EYES TO BE HAND-STITCHED WITH 3 CORD COTTON THREAD WAXED, OR MACHINE STITCHED WITH 16-4 CORD COTTON THREAD.
2. ALL MACHINE STITCHING TO BE 6 TO 10 STITCHES PER INCH CONFORMING TO TYPE 301, SPEC. DDD-S-751.
3. CUT FABRIC ON BIAS IN ONE PIECE AT 45° TO CENTER LINE.
4. PACK TO BE MANUFACTURED IN ACCORDANCE WITH SPEC. AN-P-75.
5. DIP ENDS ABOUT 3/16 TO 1/4 OF AN INCH IN A MIXTURE OF 50 PERCENT BEESWAX AND 50 PERCENT PARAFFIN.
6. BINDING TAPE TO BE STITCHED WITH 2 ROWS OF STITCHING 3/16 APART, OUTER ROW 3/32 FROM EDGE.
7. SINGLE ROW OF STITCHING IN SUB-ASSEMBLIES TO BE 3/32 FROM INNER EDGE.
8. STOCK COLUMN SHOWN FOR INFORMATION ONLY, NOT MANDATORY ON MANUFACTURER.
9. -32 AND 33 ARE SAME AS -34 AND 3 (RESPECTIVELY) EXCEPT THAT -35 AND 21 ARE NOT REQUIRED FOR Q.A.S. TYPE PACK.
10. CONE A.A.F. 36B6229 IS ACCEPTABLE ALTERNATE FOR 311394-1.
11. ONE COPY OF CODE -36 SHALL BE INSERTED IN INSPECTION TAG POCKET -6.

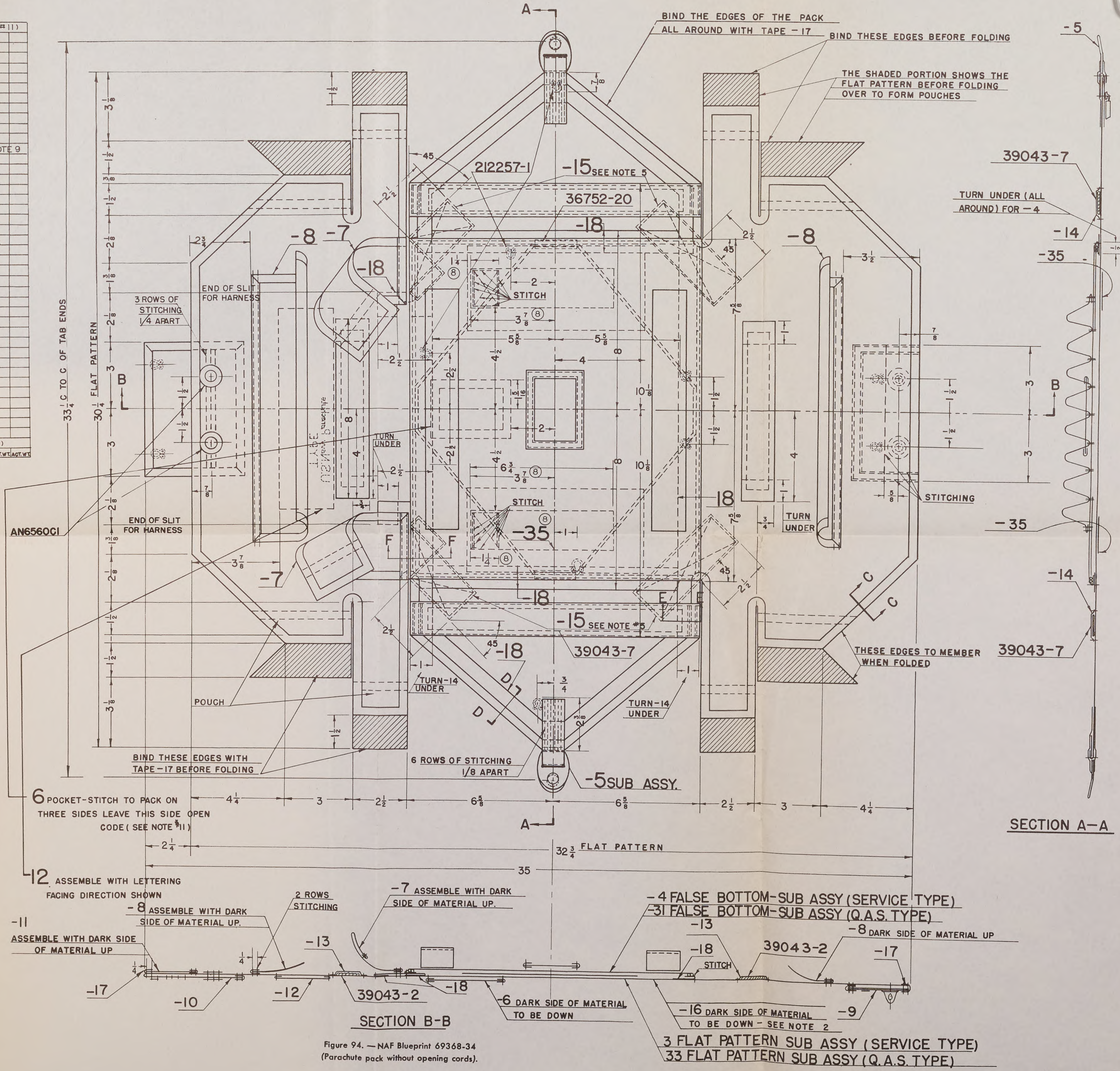

A
BIND THE EDGES OF THE PACK ALL AROUND WITH TAPE -17
BIND THESE EDGES BEFORE FOLDING
THE SHADED PORTION SHOWS THE FLAT PATTERN BEFORE FOLDING OVER TO FORM POUCHES
-5
39043-7
TURN UNDER (ALL AROUND) FOR -4
-14
-35
212257-1
-15 SEE NOTE 5
36752-20
-18
-8
-7
45
END OF SLIT FOR HARNESS
3 ROWS OF STITCHING 1/4 APART
2
STITCH
4
10 1/8
B
TURN UNDER
AN6560CI
-35
18
F
E
C
D
STITCHING
-15 SEE NOTE #5
39043-7
THESE EDGES TO MEMBER WHEN FOLDED
POUCH
TURN-14 UNDER
BIND THESE EDGES WITH TAPE-17 BEFORE FOLDING
6 ROWS OF STITCHING 1/8 APART
-5 SUB ASSY.
33 1/4 C TO C OF TAB ENDS
30 1/4 FLAT PATTERN
SECTION A-A
6 POCKET-STITCH TO PACK ON THREE SIDES LEAVE THIS SIDE OPEN CODE (SEE NOTE #11)
32 3/4 FLAT PATTERN
35
12 ASSEMBLE WITH LETTERING FACING DIRECTION SHOWN
-8 ASSEMBLE WITH DARK SIDE OF MATERIAL UP.
2 ROWS STITCHING
-7 ASSEMBLE WITH DARK SIDE OF MATERIAL UP.
-11 ASSEMBLE WITH DARK SIDE OF MATERIAL UP
-13
-17
-10
-12
39043-2
-18
-6 DARK SIDE OF MATERIAL TO BE DOWN
-4 FALSE BOTTOM-SUB ASSY (SERVICE TYPE)
-31 FALSE BOTTOM-SUB ASSY (Q.A.S. TYPE)
-13
-18
STITCH
39043-2
-8 DARK SIDE OF MATERIAL UP
-17
-16 DARK SIDE OF MATERIAL TO BE DOWN - SEE NOTE 2
-9
SECTION B-B
3 FLAT PATTERN SUB ASSY (SERVICE TYPE)
33 FLAT PATTERN SUB ASSY (Q.A.S. TYPE)

Figure 94. — NAF Blueprint 69368-34 (Parachute pack without opening cords).

has returned to the trapezoid design.

Taking into consideration the fact that no two operators work exactly the same way, and that consequently no two operators will consistently use the same tools for the same job, the following list of implements is recommended for construction of a seat-type parachute pack.

SEWING MACHINES	Type 111W150 for all general sewing. Type 144WSV37 for closing the false bottom of the container.
CUTTING TABLE	For laying out and cutting materials.
FASTENER PRESS	With dies, for setting special grommets.
MEASURING TOOLS	Yardstick, square, and 12-inch ruler.
WAX POT	With 50% mixture of beeswax and paraffin.
HAND SEWING TOOLS	Needles, palm, and flat-nose pliers.
CUTTING TOOLS	Bent trimmer's shears; 10-inch straight trimmers, and folding jackknife.

TEMPLATES

Your first step will be construction of a template for the FLAT PATTERN of the container. Figure 95 illustrates a template made from the SS container flat pattern.

A template may be cut to form from the part itself, or from a pattern of any given part taken from a drawing. The latter method is used when the part in question is inaccessible. A template is usually cut from some strong, durable material capable of standing rough handling without altering its original accuracy. Manufacturers generally use sheet metal in the construction of their templates, but fiber-board is sufficient for local loft use.

In making a template, be certain to allow for all seams, "turn unders," and hems. Normally, blueprint dimensions allow for seams and hems, and state the fact clearly. Closely observe these measurements and cut STRAIGHT lines where called for.

The main flat pattern template is that actually necessary for loft use, since the other sub-assemblies are quite small and simple in shape.

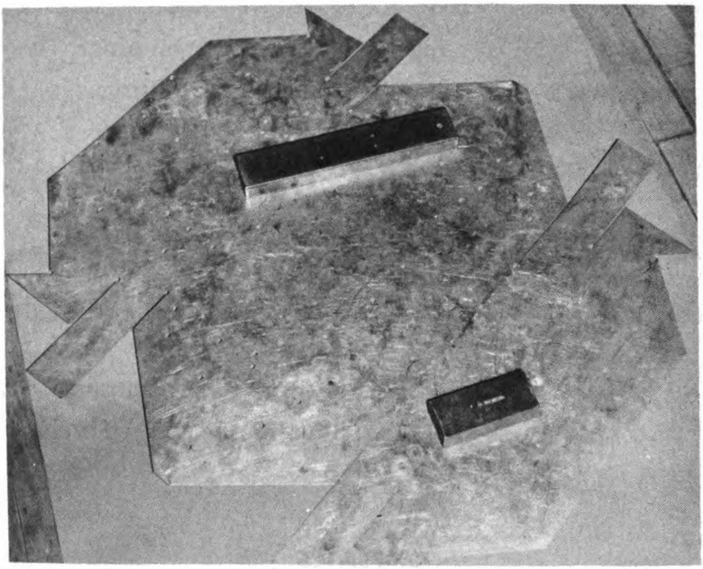


Figure 95. — Template made from SS flat pattern.

MARKING

Lay out the material — cotton processed fabric, aircraft gray in color — on the cutting table, making certain that no wrinkles or folds are present. Place the flat pattern template on the fabric in such a manner as to conform with a TRUE BIAS — 45 degrees to center line. The flat pattern of the pack is cut in one piece, and in tracing the part, press the edges of the template firmly on the surface of the fabric so as to gain accurate shape and measurements. If so much as one edge or corner curls up or down, the shape will be lacking along that particular dimension.

The greatest dimensions of the CONE FLAP are 6 x 3 inches. The flap is bound on three sides with 3/4-inch cotton tape. Type III tape is a twill-weave cotton material, while Type II is a herringbone-weave. Four pieces of hardware are stitched to this sub-assembly – two locking cones, NAF 311394-1, and two eyes, NAF 212257-1. Blueprint note number 1 (figure 94) explains that hardware may be hand- or machine-stitched, whichever method is applicable. Machine stitching of cones at the Naval Aircraft Factory is accomplished with 12 x 4-inch cord-eyes with 16 x 4 cotton thread. Hand stitching is done with # 30 x 3 cotton or linen thread DOUBLED AND WAXED.

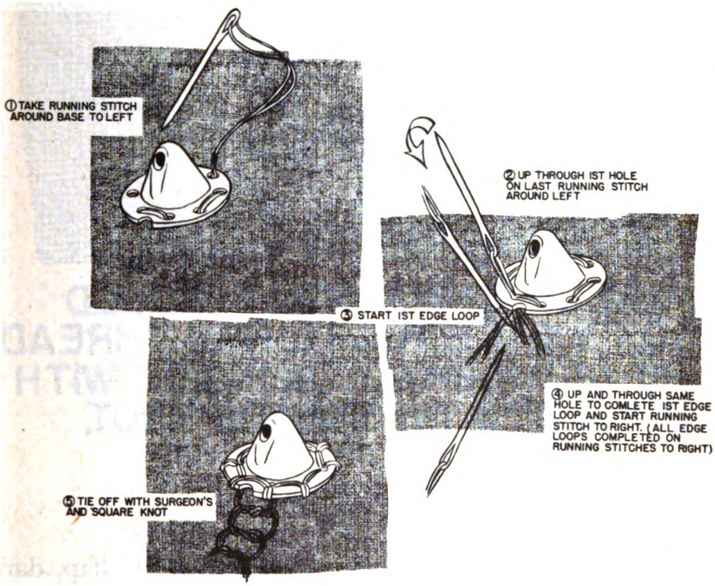
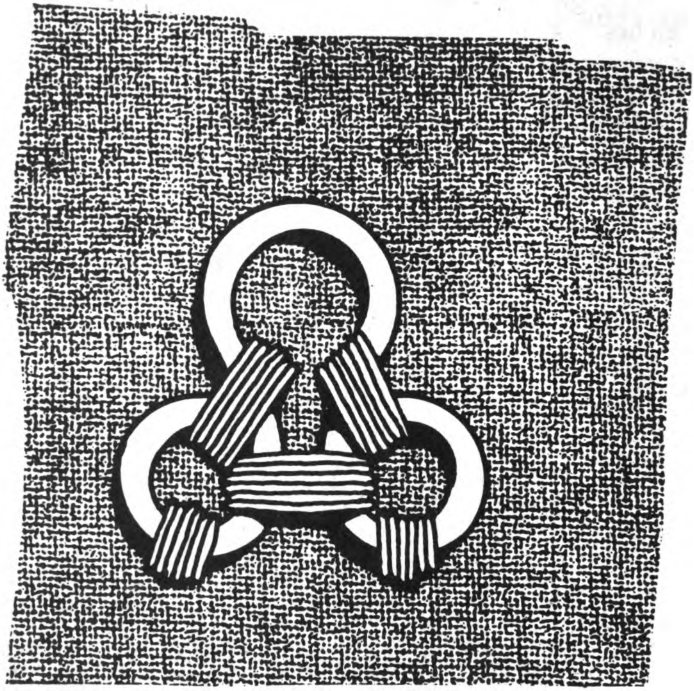

① TAKE RUNNING STITCH AROUND BASE TO LEFT
② UP THROUGH IST HOLE ON LAST RUNNING STITCH AROUND LEFT
③ START IST EDGE LOOP
④ UP AND THROUGH SAME HOLE TO COMLETE IST EDGE LOOP AND START RUNNING STITCH TO RIGHT. (ALL EDGE LOOPS COMPLETED ON RUNNING STITCHES TO RIGHT)
⑤ TIE OFF WITH SURGEON'S AND SQUARE KNOT

Figure 96. — Method of hand sewing locking cones.

Incidentally, the primary reason for waxing thread is to render it more readily adaptable, especially when the thread is doubled. The wax also protects the thread and prevents fraying.

One method of hand-sewing cones and eyes is illustrated in figures 96 and 97.



MAKE 15 TURNS WITH DOUBLED 30X3 COTTON OR LINEN THREAD. TIE OFF TIGHTLY ON INSIDE WITH SURGEON'S OR SQUARE KNOT.

Figure 97. — Method of hand sewing pack eyes.

The cones and eyes are machine-sewn to the flap, dark side up, prior to assembly on the container. Notice that sub-assembly-26 (figure 98 from NAF Blueprint 69368-34) is used as a stiffener and is made from NUMBERED DUCK, TYPE I, MEDIUM TEXTURE.

Federal Specification CCC-D-771 for DUCK COTTON, PLIED-YARNS (ARMY-NUMBERED AND TENT DUCK) is a valuable specification and should be included in your loft library.

The canvas stiffener, which is the same size as the flap, is secured to the flap by the binding and hardware sewing. When the cone flap is constructed, and before it is sewn to the container, consult the blueprint 69368-34 sub-assembly-10 (figure 99).

Next, position and sew the locking-cone flap to the flat pattern.

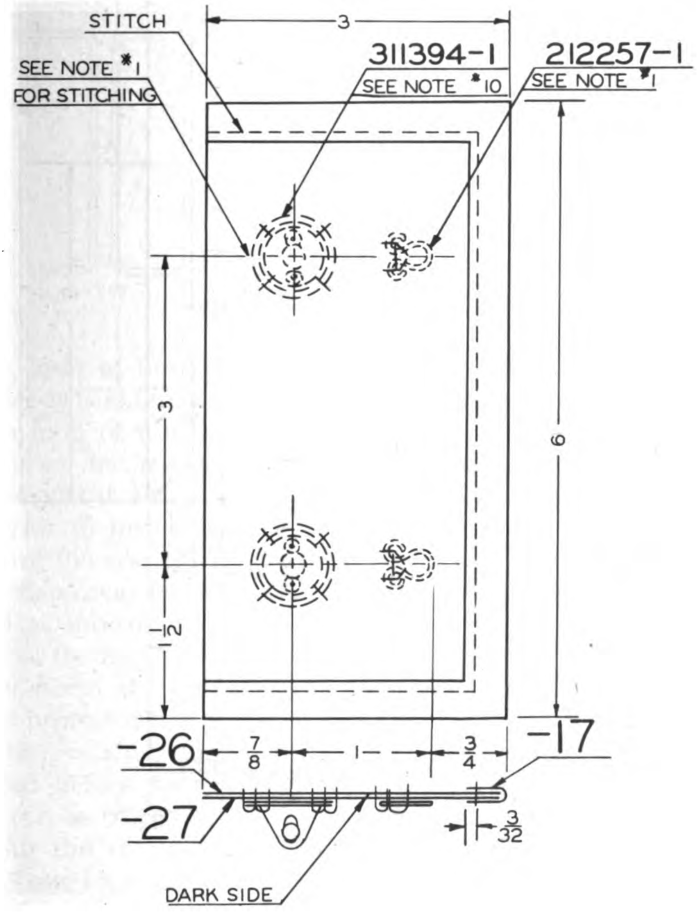


Figure 98. — Cone flap sub-assembly (-9 from NAF Blueprint 69368-34).

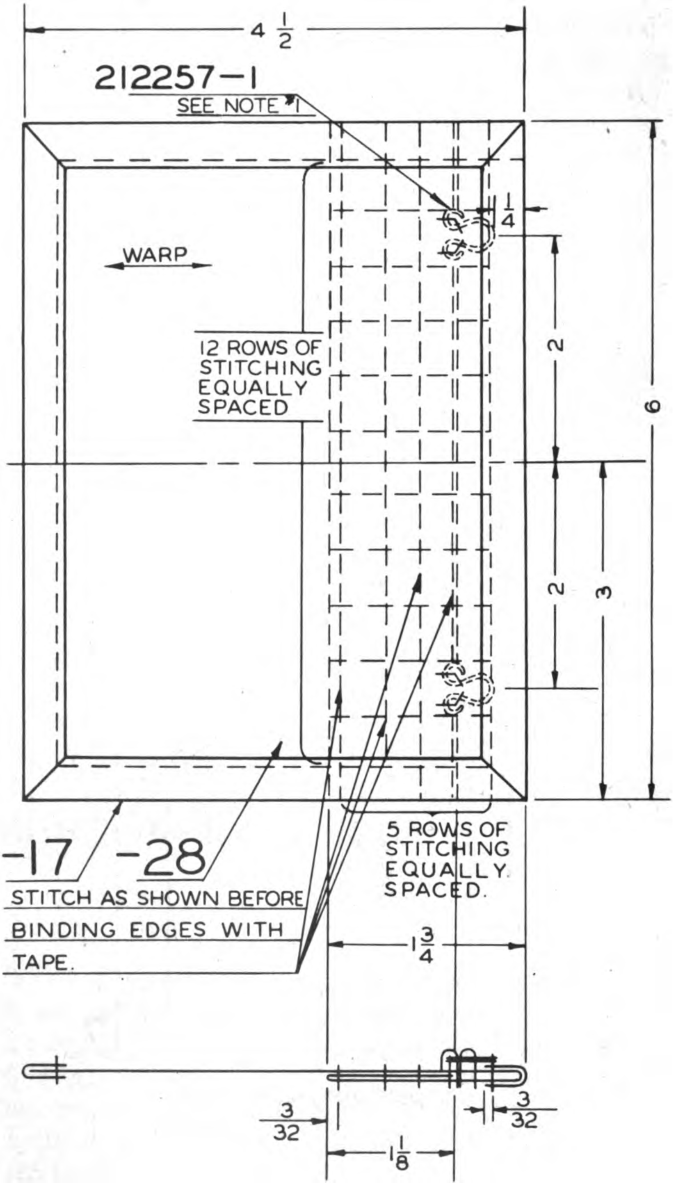

4 1/2
212257-1
SEE NOTE #1
1/4
WARP
12 ROWS OF STITCHING EQUALLY SPACED
2
6
2
3
-17
-28
STITCH AS SHOWN BEFORE BINDING EDGES WITH TAPE.
5 ROWS OF STITCHING EQUALLY SPACED.
1 3/4
3/32
3/32
1 1/8

Figure 99. — Rip cord protection flap sub-assembly (-10 from NAF Blueprint 69368-34).

As regards machine-stitching, blueprint note number 1 (figure 94) states that "all machine stitching to be with cotton thread conforming to Federal Specification, V-T-276, Type 1B3, #16 x 4 aircraft gray." Blueprint note number 2 supplies information regarding the length of stitches. Check your stitching to see that it falls within the range of six to ten stitches per inch. TYPE 301 STITCH is the LOCK-TYPE STITCH formed of two threads, an example of which is shown in figure 100.

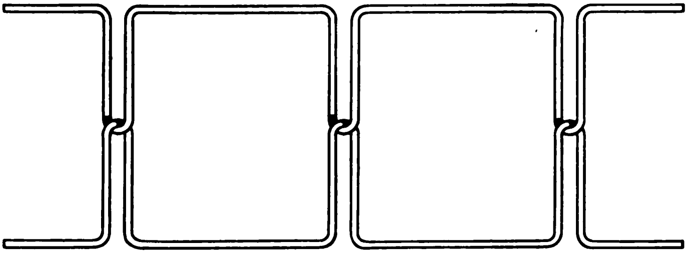


Figure 100. — Lock stitch (type 301).

A loop of one thread is passed through the material, where it is entered by the mass supply of the other thread. The loop of the first thread is then drawn into the material so that the concentration is approximately halfway between the two surfaces.

Prior to installation of the rip cord protector flap -28, (figure 99) construct sub-assembly (figure 101) -11, which is a flap-cover for this sub-assembly, sewn to the flap pattern as shown in section B-B (figure 94), with the dark side of the material up. Assembly of the dark side uppermost keeps the aircraft gray color on top when the rip cord protector flap is folded and held in place by the pack-opening elastics. Two further operations must be completed before the protector flap can be sewn to the flat pattern or true bottom of the container.

Cut the required of -18 (see cross section B-B, figure 94), one-inch cotton herringbone tape of unbleached color, and sew to the "inner" rectangular shape and end flaps of the flat pattern. This tape greatly reinforces the edges of the true bottom, where such reinforcement is really needed. Notice that a short 2 1/2-inch strip of one-inch tape runs into the grommet-side of the container to furnish added strength at the lift web or riser cuts. The tape is sewn with a single row of stitching running along all sides 3/32-inch from the edges.

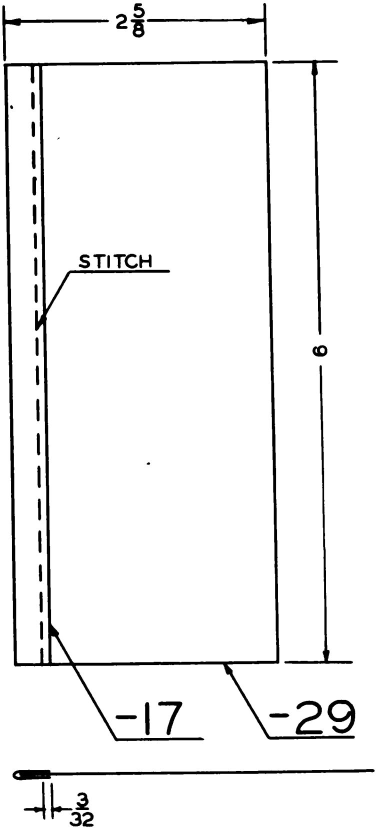


Figure 101. — Flap cover sub-assembly (-11 from NAF Blueprint 69368-34).

Bind the edges of the flat pattern with 3/4-inch herringbone or twill cotton tape, aircraft gray in color. Care must be taken to bind the designated ends of the corner and end flaps prior to binding the perimeter of the container. When the ends are bound in place, making appropriate corner and end flaps, or pouches, the binding tape is sewn with two rows of stitching approximately 3/16-inch apart, the outer row 3/32-inch from the edge. Section C-C (figure 102) shows rows of stitching 1/4-inch apart to allow a tolerance.

Position and sew the rip-cord protector flap-10, (figure 99), referring to the flat pattern and Section B-B for assembly instructions.

Mark and cut the webbing, Type VI cotton, to be used as reinforcement for all four corners of the "inner" flat pattern. Blueprint note number 5 reminds you that the ends of the webbing must be dipped in a hot-50-50 mixture of beeswax and paraffin to a depth of 3/16- to 1/4-inch to prevent fraying of the severed ends. When dry, sew the webbing at an angle of 45 degrees to the grommet and cone sides of the container. These reinforcements prevent the corners from turning outward.

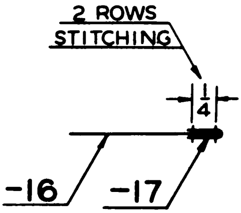


Figure 102. — Section C-C (from NAF Blueprint 69368-34).

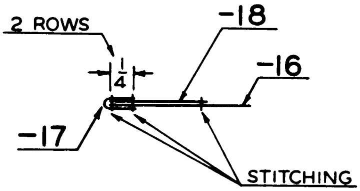


Figure 103. — Section D-D (from NAF Blueprint 69368-34).

Position and hand-sew the six bottom eyes. These eyes may also be machine-sewn, using a special machine with #16 x 4 cotton thread. Some manufacturers use "E" silk thread.

Mark and cut the 1-1/2-inch-wide herringbone tape to be used as pockets for the container stiffeners. The side flap stiffeners are shorter than those used on end flaps. Refer to proper NAF drawings for detailed data concerning container stiffeners. The ends of each of these pockets are turned under one inch and sewn with a single row of stitching completely around all sides, 3/32-inch from the edge. A good procedure is to sew three sides, slip in the stiffener, then complete the job, using a BACK-STITCH to secure all sewing. In Section E-E of the drawing (figure 104), note the manner in which the end flap stiffener pockets are sewn.

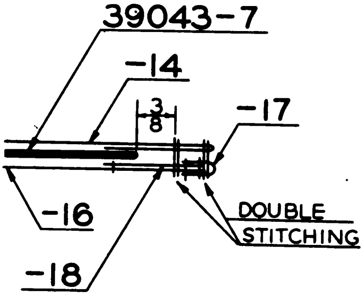


Figure 104. — Section E-E (from NAF Blueprint 69368-34).

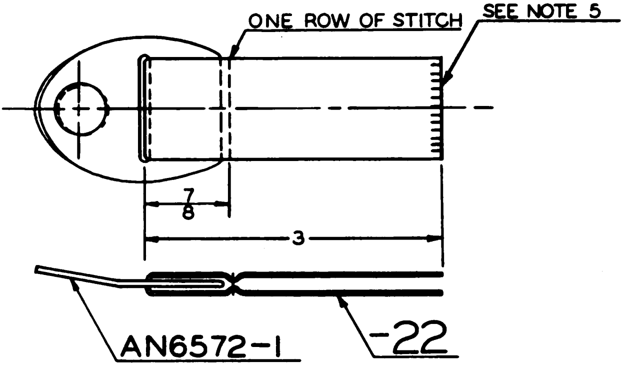


Figure 105. — Webbing tab (-5 from NAF Blueprint 69368-34).

Mark and cut the two pieces of one-inch aircraft gray cotton webbing -22 (figure 105), used to secure end tab AN6573-1 to the container. The ends must be dipped in accordance with blueprint note number 5. Pass the webbing through the hardware and position it on the container, making certain that the bent portion of the end tab is facing the INSIDE of the container.

In a copy of the present NAF END-TAB DRAWING, illustrated in figure 106, the end-tab webbing is sewn to the container with six rows of stitching 1/8-inch apart.

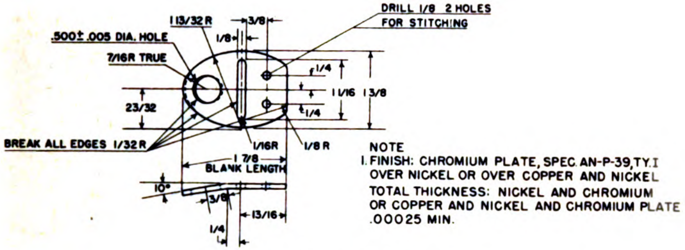


Figure 106. — Metal end tab.

Position and sew the last two eyes to the end flaps. Notice that one eye is sewn directly on top of the end-tab webbing, while the other is offset.

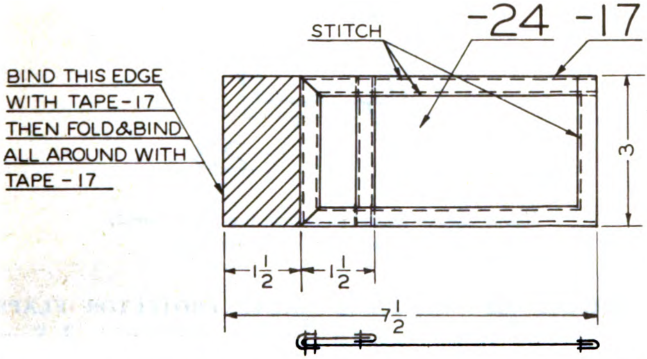


Figure 107. — Corner flap sub-assembly (-7 from NAF Blueprint 69368-34).

Construct, position, and sew the required two lift-web protector flaps. For specifications and dimensions, refer to -7 (figure 107). The flat pattern, Sections B-B and F-F (figures 94 and 108), will furnish the additional information necessary for assembly of the container.

Construct, position, and sew the packing data card pocket to the outside of the container, consulting -6 (figure 109), for dimensions and specifications. Section B-B (figure 94) and the flat pattern will explain how and where to assemble this part to the container.

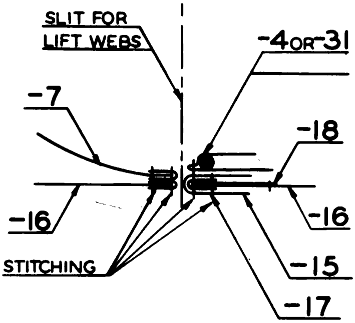


Figure 108. — Section F-F (from NAF Blueprint 69368-34).

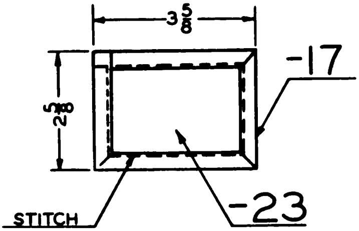
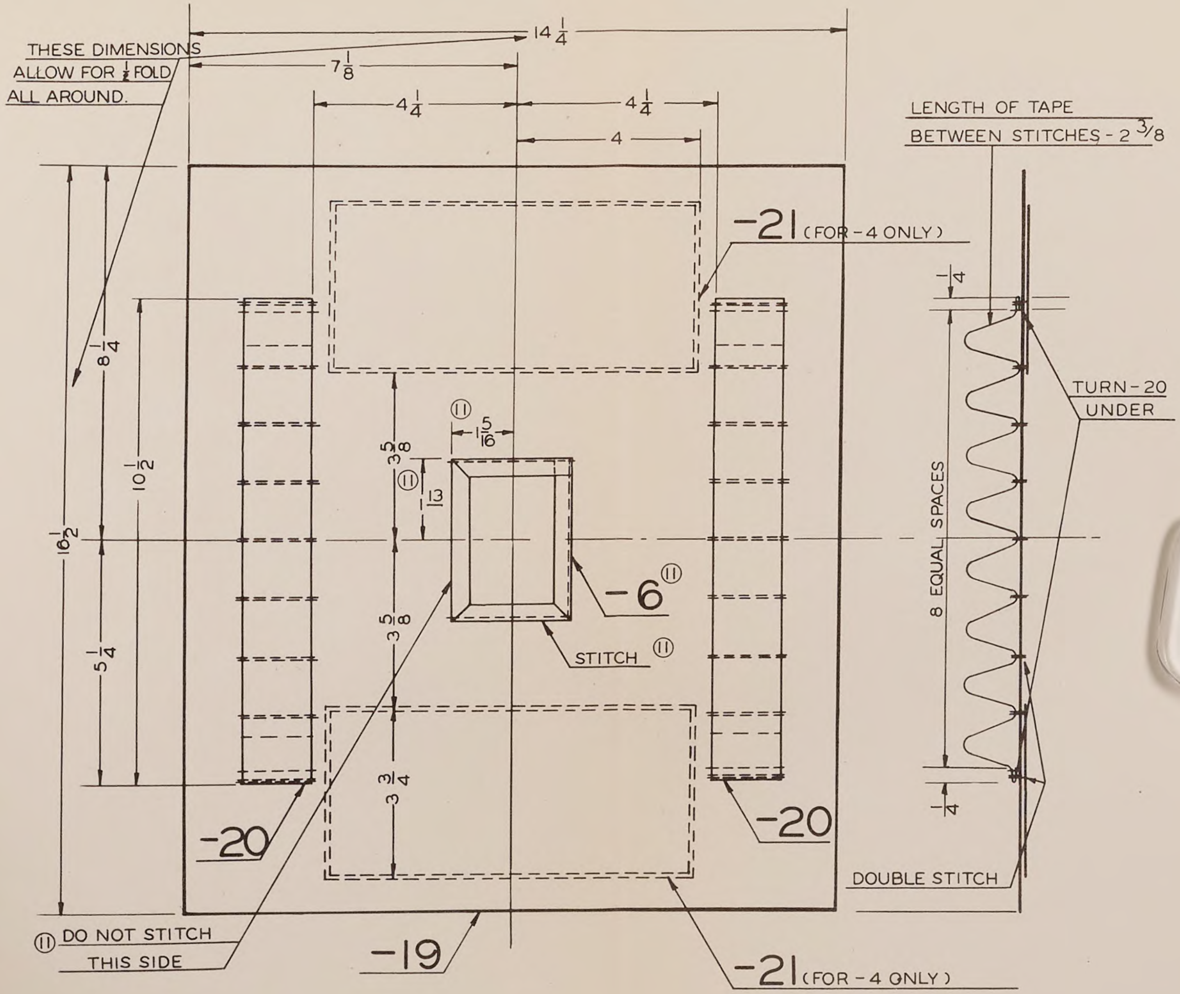


Figure 109. — Pocket inspection tag sub-assembly (-6 from NAF Blueprint 69368-34).

Construct the two PILOT CHUTE PROTECTOR FLAPS -8 (figure 110). Reference to the flat pattern and Section B-B will indicate that the long side not bound with tape is the SELVAGE EDGE.

You are now ready to make the false bottom. Mark and cut -19 (figure 111), the dimensions of which are 14-1/4 x 16-1/2, allowing for 1/2-inch fold all around. Sew -21, which is nothing more than a reinforcing patch (two are required) to the underside or dark side of the



⑪ ASSEMBLE WITH DARK SIDE OF -19 & -6 DOWN

Figure 111.—False bottom sub-assembly—QAS type (-31 from NAF Blueprint 69368-34).

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false bottom. Carefully mark out all hesitator loops, following instructions contained in Section A-A (figure 94) and -4 (figure 111). Sew each hesitator loop by starting in the middle of the tape and working to one edge. Pass three stitches over the edge and proceed to the opposite side, sewing past by the same number of stitches and finishing in the center, thus completing the double stitching.

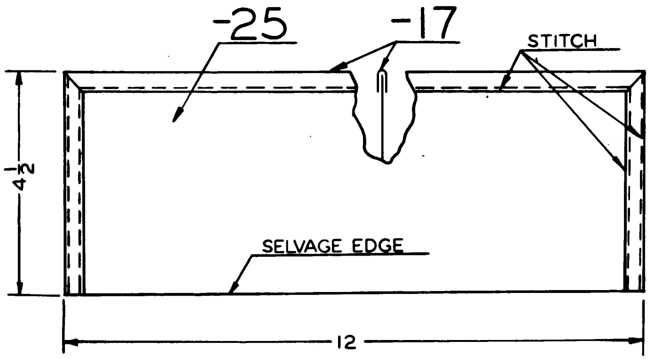


Figure 110. — Pilot chute flap sub-assembly (-8 from NAF Blueprint 69368-34).

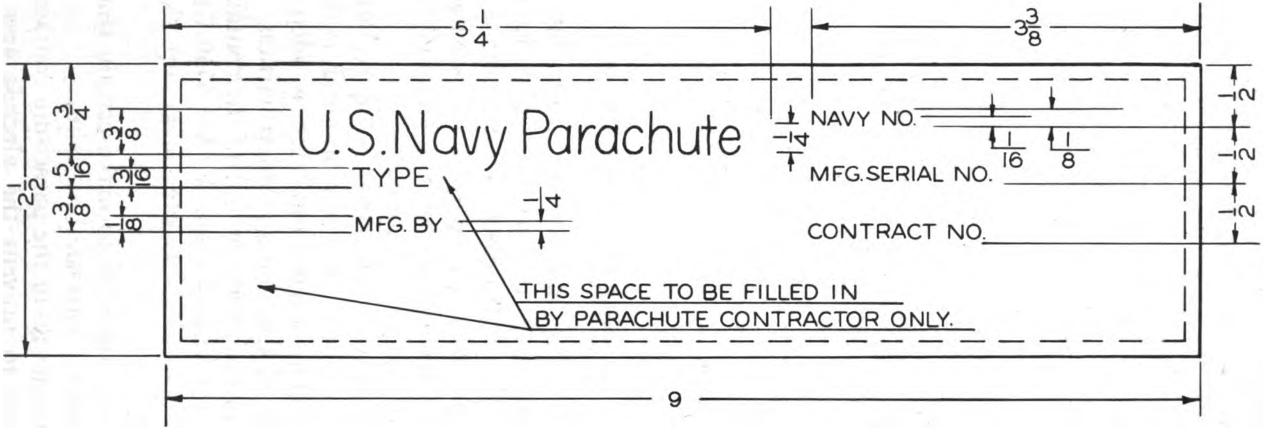
Sew three sides of the false bottom to the flat pattern, referring to Section B-B, Section A-A, and Section F-F (figures 99 and 108) for all necessary information. Then insert the frame, 36752-20, and complete the sewing. The use of a 144 Class sewing machine is recommended for the final closing of the false bottom.

Mark and cut -35 HARNESS KEEPERS (figure 94), which e 6-3/4 inches in length, and sew one end as shown in the flat pattern. The length indicated is adequate for future installation of a split-sling design harness.

Cut two holes in the grommet side of the container and set the special grommet and washers (AN 6550 CI), using the necessary special dies. Lastly, make up the name plate, -12 (figure 112).

Inspect the entire assembly to make certain that everything is in accordance with the blueprint.

Throughout the design of the parachute container, care has been exercised to prevent the aircraft gray side of



DIMENSIONS GIVEN ARE AFTER FOLDING 1/8 ALL AROUND.
PRINT ALL LETTERS ON DARK SIDE OF MATERIAL.
FOR MARKING USE FLUID SPEC. AN-F-39

Figure 112. — Name tag (-12 from NAF Blueprint 69368-34).

the cotton processed fabric from facing inside the container. This is to keep the inside free from all color pigments and thus prevent possible damage to the canopy.

MINOR REPAIRS

The term MINOR REPAIRS applies to those operations considered superficial in nature which may be carried out in the field with a minimum of equipment. Such repairs are readily made by any activity having qualified personnel and the proper equipment.

The replacement of pack opening elastics, pack assemblies, QAC body harnesses, rip cords, and other parachute parts and accessories, are included under the heading of minor repairs, thus defining the term more explicitly as GENERAL MAINTENANCE OF THE PARACHUTE.

Repairs of the above nature do not as a rule require extensive reference to blueprints and specifications. The operator may be guided as to details by the construction of the chute undergoing repairs.

The following list of minor repairs can be carried out in the loft without necessitating shipment of the parachute to a major overhaul station:

REPLACEMENT	Container and sub-assemblies. Hand pull pockets. Rip cord housings. Rip cord assemblies. Pilot chutes and frames. Vent rings. Straight stitchings (NOT zigzag stitching).
PATCHING	Containers or packs. Canopy — a hole or tear not exceeding eight inches at its greatest dimension in 1, 2, and 3 sections. A tear of eight inches in the top section (24-foot canopy) is considered too great for the area and consequently requires renewal of the entire section, thus constituting a major repair.

MAJOR REPAIRS

The term MAJOR REPAIR includes, in addition to work listed under minor repair, all operations necessary to place the parachute in first-class condition. Such operations are normally not undertaken by local operating units because of insufficient equipment and lack of highly-trained personnel.

The major repair station is a fully-equipped parachute overhaul unit capable of manufacturing an entire assembly if so required. The designated major repair stations are AUTHORIZED to effect any repair, or to rebuild the parachute consistent with the cost of material and labor involved.

The following is a list of major repairs carried out by authorized major overhaul stations:

REPLACEMENT	Canopies.
	Harnesses (fixed types).
	Gores.
	Sections — a hole in excess of eight inches will probably require replacement of the entire unit. Sections which have been patched twice are not given a third patch, but are renewed.
	Shroud lines.
	Vent collar.
CONSTRUCTION	Of certain designated assemblies. The NAVAL AIRCRAFT FACTORY is the only government-owned parachute factory designated to completely manufacture parachutes.

The satisfactory repair of parachutes involves an understanding of the proper methods and materials to be employed, and a conscientious application of such knowledge.

In the following pages, a number of repairs are outlined for the purpose of serving as a guide. It must be pointed out that the following repair descriptions are not representative of all repairs under all circumstances, nor are the general working patterns recommended to be considered the sole method of performing such work.

PILOT CHUTE

If the pilot chute has deteriorated to such an extent that repairs are impractical and uneconomical, or if the efficiency of the operation of the pilot chute has been impaired, substitution of a new pilot chute is mandatory.

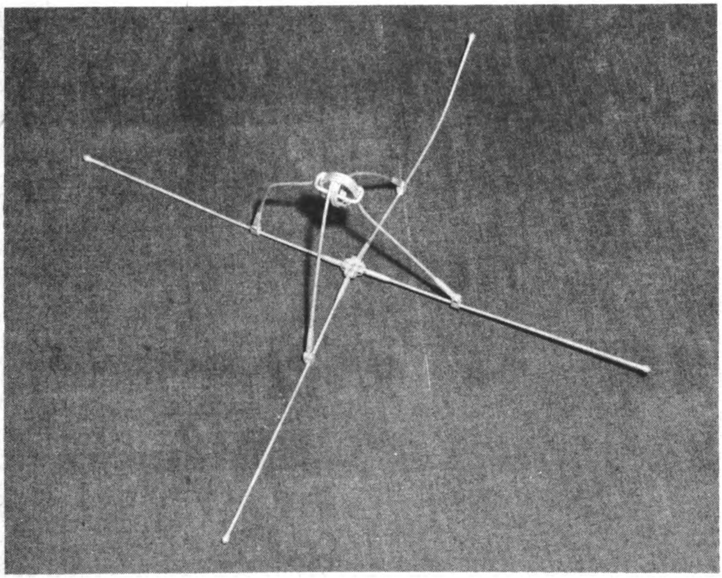


Figure 113. — Damaged pilot chute frame.

If the SPRING IN THE FRAME is weak, broken, or bent so that it cannot be straightened, or if evidence of deterioration is present, REMOVE AND REPLACE with a new frame.

In figure 113, notice the badly bent OUTER SPRING, requiring replacement, and the slightly bent RIB which needs straightening.

Prior to inserting a new frame, lubricate each of the movable parts with a slight application of PETROLATUM, or its equivalent, to increase the smoothness of operation and to prevent rust.

The RIB POCKETS occasionally become punctured where the ends of the ribs bear against the fabric. This is especially true of frames fashioned from older blueprints, since they were not provided with protective ball-ends but were merely wrapped with adhesive tape. When this damage occurs, the rib pocket must be replaced.

Never repair broken shroud lines by joining them with knots or splices. THEY MUST BE REPLACED.

If a shroud line is torn loose at its anchorage to the pilot chute canopy it should be patched, if necessary, and re-attached using not less than eight and not more than 12 zigzag stitches to the inch. Zigzag stitches (SP1) are counted on the SIDE ROW OF STITCHING. This point is illustrated in figure 114.

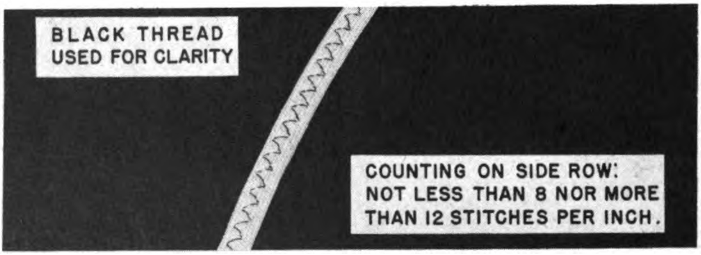


Figure 114. — Zigzag stitching.

The re-attachment of shroud lines is a painstaking job demanding great concentration and care. The process will vary with the different pilot chutes in service use. In one type of pilot chute, the shroud lines terminate at "center peak," while in others each shroud line ends two inches from the skirt.

In pilot chutes with loops formed by the alternate method of zigzag stitching, the suspension lines cannot be replaced singly as may be done with the served-loop type. A broken line in a pilot chute having the former arrangement would require the opening and re-sewing of ALL LINES at that point in order to replace ONE LINE. Therefore, we may estimate that one damaged line in a pilot chute with a zigzag loop sewing makes replacement of the entire pilot chute canopy necessary. Two methods of making a pilot chute loop are shown in figure 115.

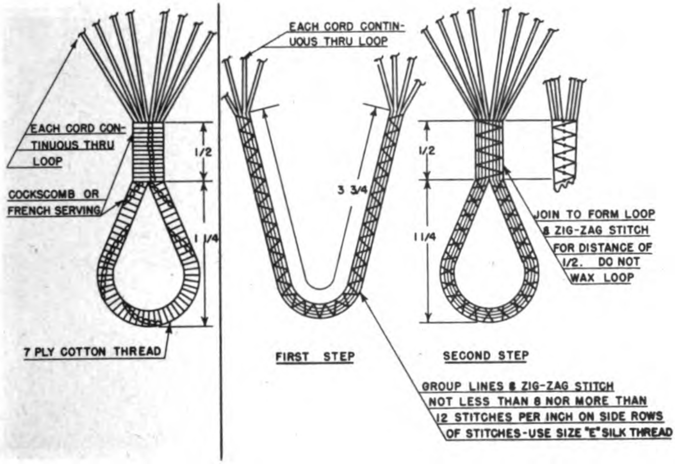

EACH CORD CONTINUOUS THRU LOOP
1/2
COCKSCOMB OR FRENCH SERVING
1 1/4
7 PLY COTTON THREAD
EACH CORD CONTINUOUS THRU LOOP
3 3/4
FIRST STEP
1/2
1 1/4
SECOND STEP
JOIN TO FORM LOOP & ZIG-ZAG STITCH FOR DISTANCE OF 1/2. DO NOT WAX LOOP
GROUP LINES & ZIG-ZAG STITCH NOT LESS THAN 8 NOR MORE THAN 12 STITCHES PER INCH ON SIDE ROWS OF STITCHES-USE SIZE "E" SILK THREAD

Figure 115. — Method of constructing pilot-chute loop.

If the canopy of the pilot chute becomes torn or chafed, repairs are made in the same manner as described under main canopy repairs.

A damaged or soiled pilot chute connector cord (bridal cord) should be replaced. The construction of a connector cord is shown in figure 116.

VENT COLLAR AND RING

The vent collar is a "straight construction," and measures 11 x 58 inches, (24-foot canopy), flat pattern. This sub-assembly is joined along the short edge with a 7/16-inch seam, Type LSc-2. The collar in turn is attached to the vent hem of the canopy, using seam Type LSd-2, which is a one-inch seam with a one-half-inch turn-under.

With the use of seam Type EFb-1, the vent-closing elastic is sewn in the top of the vent with a one-inch hem with a one-half-inch turn-under. The finished and sewn collar is approximately eight inches high. Figure 117 is an NAF drawing of the vent-closing elastic.

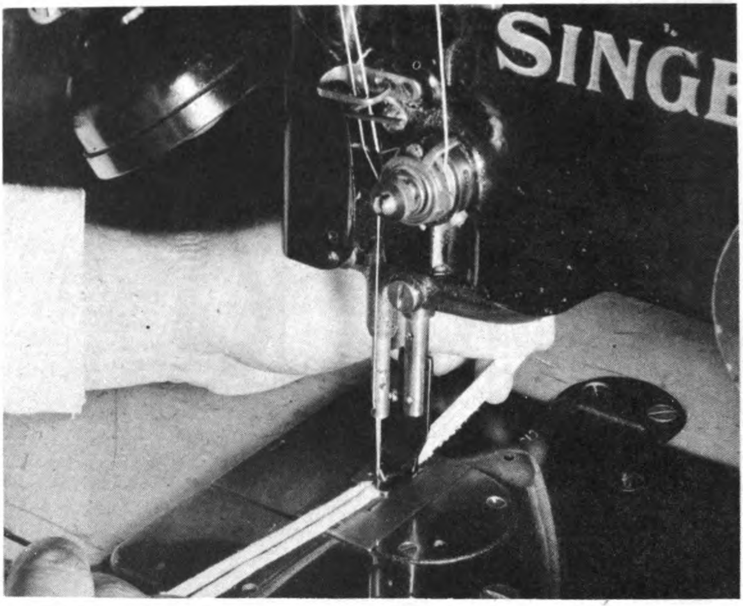


Figure 116. — Construction of a connector cord.

CANOPY

Maintaining a consistent amount of elasticity throughout the canopy is absolutely essential. When inserting a patch you must, therefore, take pains to ascertain that the direction of threads, warp, and filling match those of the canopy. These precautions are necessary to prevent cross-strains and subsequent distortion and damage to the patched area at the time of opening shock.

WARP THREADS RUN LENGTHWISE of bolt fabric and are PARALLEL TO SELVAGE EDGES. FILLING THREADS extend across the width of the fabric and are PERPENDICULAR TO SELVAGE EDGES. If there are no selvage edges for guidance, you ordinarily can spot filling threads by their greater coarseness, and there are also fewer filling threads per inch than warp threads.

Both warp and filling threads meet the center line of a gore or section at 45 degrees because the material is cut on a bias. Warp threads run parallel to the diagonal seams.

Warp and filling threads of a patch must be parallel to the warp and filling threads of the canopy.

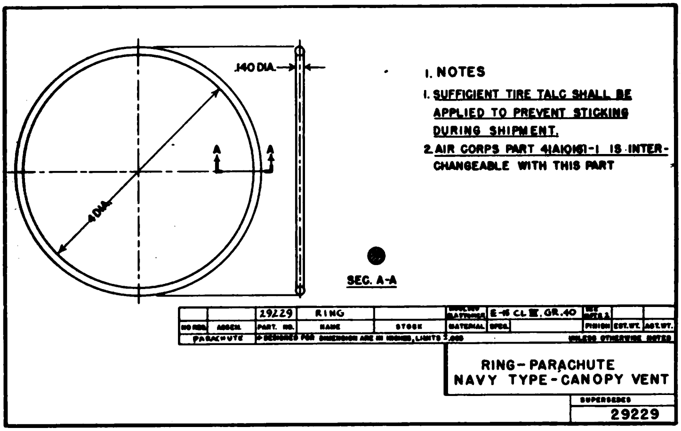


Figure 117.— Vent-closing elastic.

PATCHING

Rips, snags, tears, holes, and acid-burned areas are repaired by PATCHES. A DOUBLE PATCH is used in most repairs, one patch being located on the inside of the canopy, the other on the outside. The inner patch, which is smaller than the outer, is applied first. If the opposite were the case, the stitching of the smaller patch would pass through the larger.

It is well to remember the rule about using A MINIMUM NUMBER OF STITCHES TO SECURE A MAXIMUM AMOUNT OF STRENGTH. This is a habit all Parachute Riggers should acquire.

It has been stated that tears greater than eight inches constitute a major repair and overhaul, but there are also occasions when a two-inch tear will require major attention, depending on the location of the damage. A two-inch tear through a radial seam which has severed the shroud lines, or a two-inch tear through the skirt or vent hems which has damaged the reinforcing tape and webbing, constitutes a major repair. Whenever a tear extends from one section to another, or from gore to gore, a major repair operation is indicated. An illustration of a tear extending from one section to another is shown in figure 118.

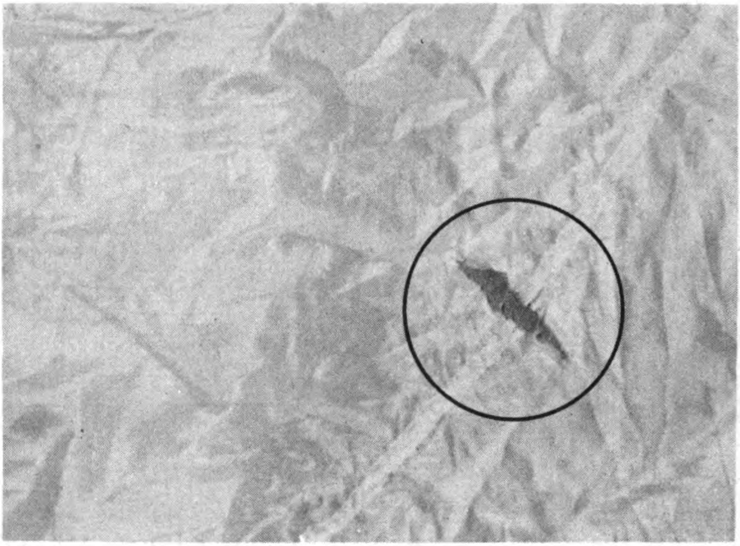


Figure 118. — Tear extending across two sections.

PATCH OVERLAP

To what extent should the inner patch overlap the damage, and what distance should the outer patch overlap the inner patch?

A small hole one inch in size can be satisfactorily repaired by application of a single outside patch. But where is the line drawn? Where will you base the determination as to whether one or two patches are required?

Attention is drawn to the rule regarding minimum stitches and maximum strength. If two patches were used to repair a one-inch tear, the effect of so many concentrated stitches would be weakening and thus defeat the intended purpose.

Any patch should overlap the damage sufficiently to form a secure hold without danger of tearing free. In repairing a one-inch tear, it is wise to overlap the repair area a full inch.

Two patches, inner and outer, are required for the repair of tears two inches or more in extent. An overlap of one inch all around the damage for an inner patch is sufficient for tears of from one to three inches, while an overlap of one and one-half inches is necessary for tears ranging from three to six inches. Tears greater than six inches and not larger than eight inches require two inches of overlap.

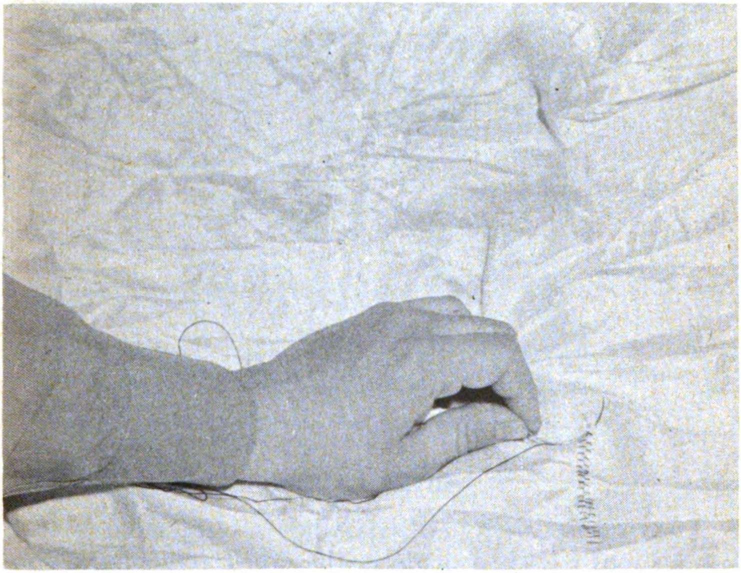


Figure 119. — Baseball-stitching a tear.

The outside patch must overlap the inner patch by one inch for all tears up to eight inches. All patches, whether inside or outside, are applied with a one-half inch hem which has been previously basted.

MAKING A PATCH

Trim the tear, cutting away all ragged edges, then proceed to BASEBALL STITCH the damage, using size "E" silk or nylon thread. Do not pull the stitches too taut. This will prevent creation of a series of puckers. When the last stitch has been taken and tied off with a surgeon's knot, the damaged area should lie flat and in no way draw the fabric out of line. In figure 119, the operator is baseball-stitching a four-inch tear. In this illustration, black thread has been used to enhance the drawing.

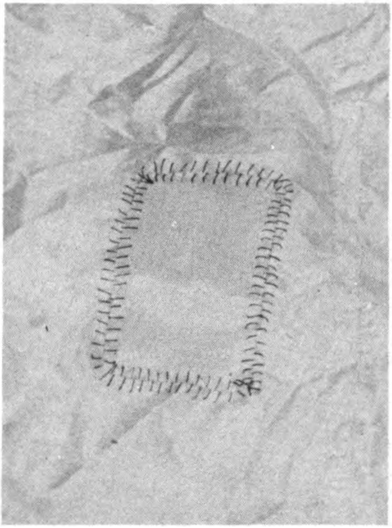


Figure 120. — Filler patch baseball-stitched in place.

FILLER PATCH

A FILLER PATCH is necessary when a blunt hole of such proportions has been made in the fabric removing a considerable amount of material, or so damaging the area that the trimming process has left a gaping hole.

After matching the warp and filler threads, cut a piece of fabric the same size as the trimmed hole. This piece is then set in place and baseball-stitched around the edges. Do not cut the filler patch too small or too large, as such a procedure will cause pulls and puckers. Figure 120 illustrates the filler patch baseball-stitched in place.

APPLYING INSIDE AND OUTSIDE PATCHES

When marked, cut, and basted, the inside patch is ready for application to the inside of the canopy.

The patch may be basted to the canopy before being machine-sewn. Basting the patch is excellent practice for beginners. Basting may be done with size "B" silk thread, and is removed after the piece has been permanently secured.

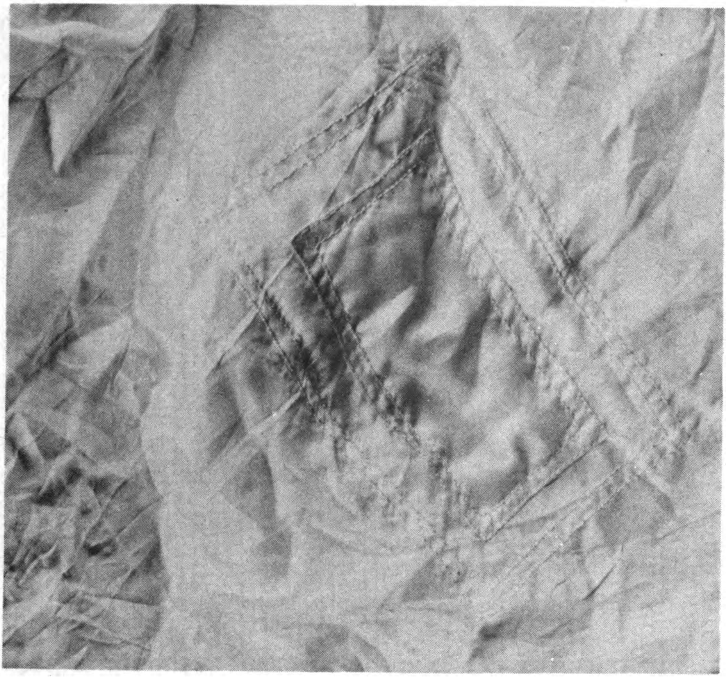


Figure 121. — Inside patch.

In basting or sewing the patch to the canopy, make certain that no excess material is under the part being sewn. Make two rows of stitching all around the patch with a light-duty sewing machine, using size "E" silk or nylon thread corresponding to the material being repaired. The outer row of stitching is first sewn 1/16-inch from the edges, using eight to 10 stitches per inch. The second row is made 5/16-inch from the outer row of stitching, thereby completing the machine-sewing of the inner patch. In figure 121, which illustrates this step in patching, the stitching from the outer patch was applied last.

Whenever possible, anchor all patches to a seam.

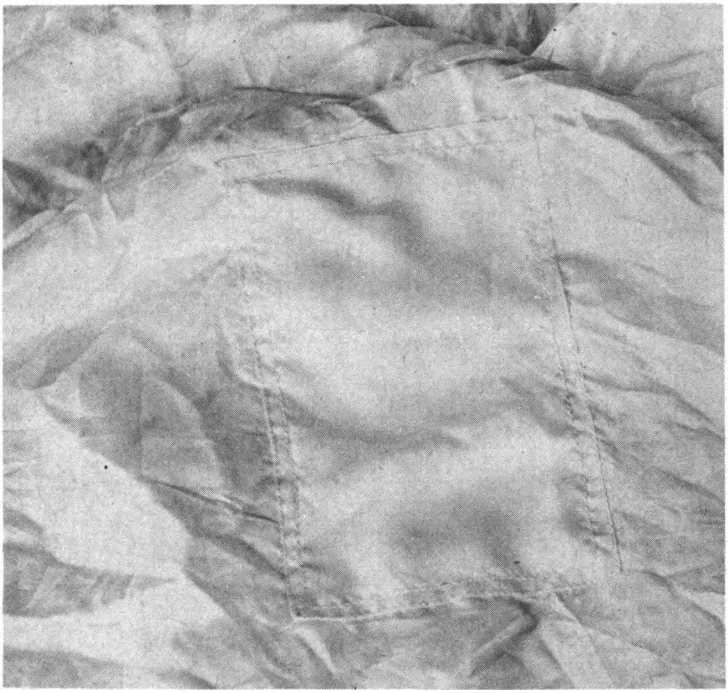
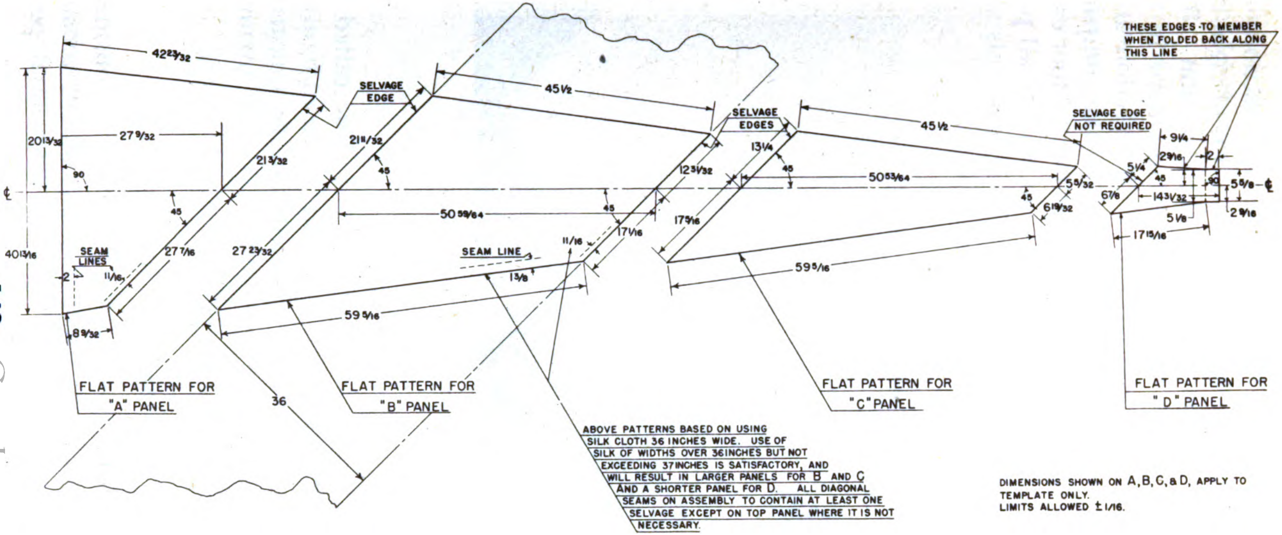


Figure 122. — Outside (last) patch.

The outside patch is applied exactly as the inner patch, and is pictured in figure 122.

WHEN SEWING A PATCH TO A RADIAL SEAM, DO NOT SEW THROUGH THE SUSPENSION LINE.

When it becomes necessary to make more than two patches on any one section, the section should be replaced.



ABOVE PATTERNS BASED ON USING SILK CLOTH 36 INCHES WIDE. USE OF SILK OF WIDTHS OVER 36 INCHES BUT NOT EXCEEDING 37 INCHES IS SATISFACTORY, AND WILL RESULT IN LARGER PANELS FOR B AND C AND A SHORTER PANEL FOR D. ALL DIAGONAL SEAMS ON ASSEMBLY TO CONTAIN AT LEAST ONE SELVAGE EXCEPT ON TOP PANEL WHERE IT IS NOT NECESSARY.

DIMENSIONS SHOWN ON A, B, C, & D, APPLY TO TEMPLATE ONLY.
LIMITS ALLOWED ± 1/16.

Figure 123. — Respective areas of A, B, C, and D Panels.

A six or eight-inch tear remains a minor repair so long as the tear is not in the D Panel (top section) section. This area is much smaller than others, and a tear of eight inches damages practically one entire side of the section. Therefore, any tear greater than six inches in extent in the D section constitutes a replacement of that section and becomes a major repair. Figure 123 show the comparative sizes of the sections comprising a gore in a 24-foot canopy.

Use NEW fabric — silk or nylon — in making all patches and canopy repairs. Silk and synthetic materials should not be used in the same canopy assembly.

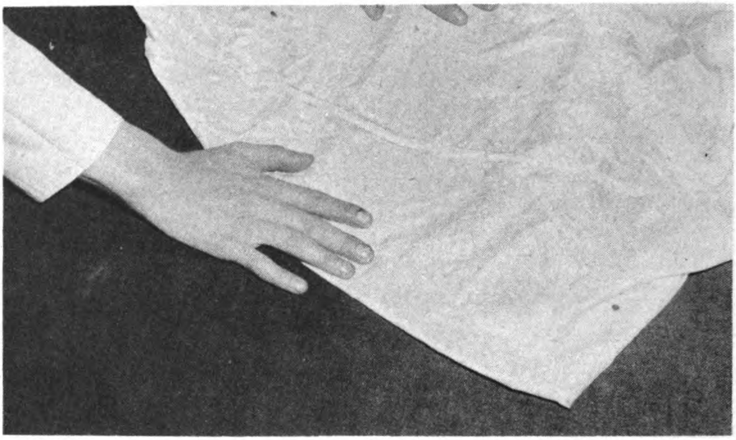


Figure 124. — Seam rupture.

RUPTURES

The occasion may arise when you will be called upon to repair a seam rupture such as that shown in figure 124, so that it will resemble the repaired rupture appearing in figure 125. Pay particular attention to the manner in which the patch has been applied.

SHROUD LINES

The re-stitching of shroud lines requires considerable concentration and care, since a re-attachment constitutes a second sewing, thus causing many additional perforations in the comparatively small area of the line. Tests have shown that a second sewing in the same area reduces the tensile strength of a shroud line by as much as 50 percent. One can readily understand the hazards of reattachment where numerous suspension lines have been torn loose in any one area of the canopy. If more than one line is torn from the skirt or vent, the only safe alternative is REPLACEMENT of the line.

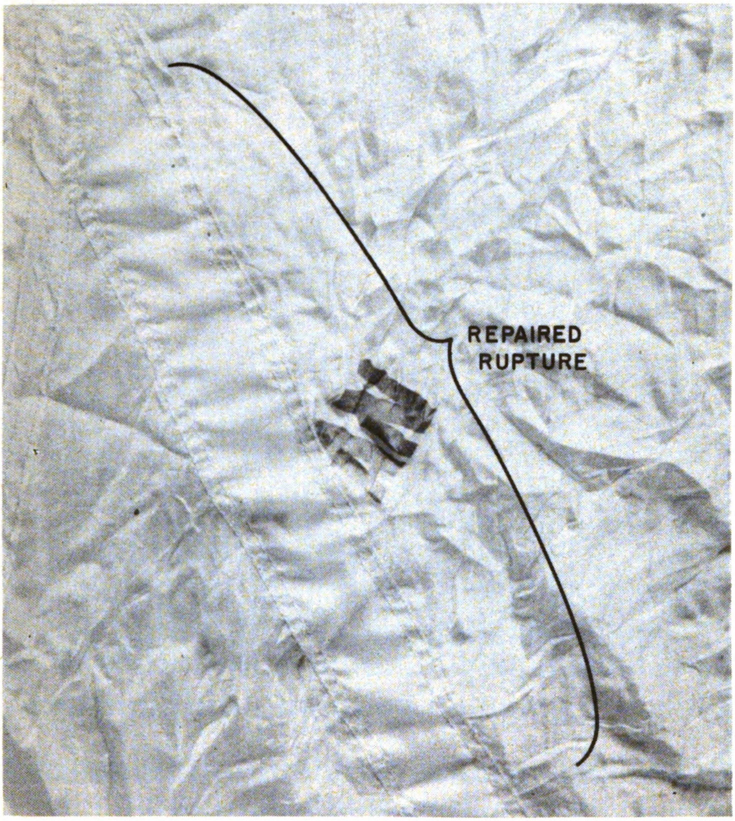


Figure 125. — Repaired seam rupture.

The renewal of shroud lines MUST be undertaken by an overhaul shop equipped with the necessary facilities for making such repairs. Your job as a Parachute Rigger not attached to a major overhaul station is to be constantly alert for shroud lines that are acid-stained, frayed, torn, chafed, or otherwise damaged. Upon finding such condition, tag the line for ready identification in the overhaul shop.

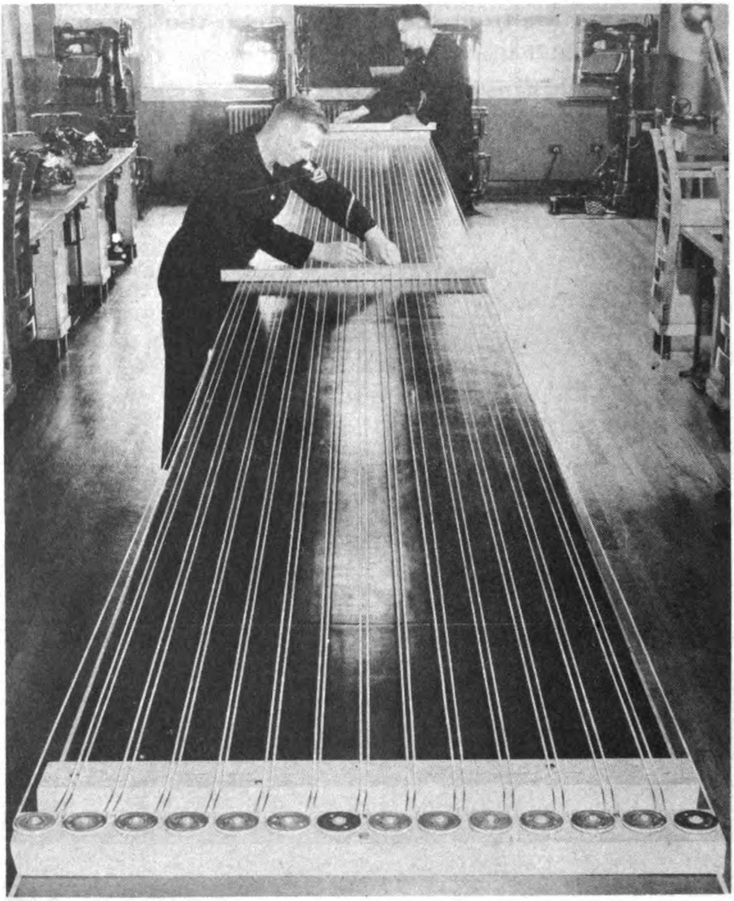


Figure 126. — Laying out and marking shroud lines.

When one or two inner cords protrude from a loop through the shroud covering, use a blunt tool to replace them. If the inner cord is severed, it should be replaced. NEVER TRIM LOOSE THREADS FROM SUSPENSION LINES.

Have you noticed the colored inner cords in a shroud line? These cords constitute a code by which the manufacturer of the cordage may be identified.

A copy of the AN Specification for CORD NYLON, AN-C-63a is included in Apendix III. You are advised to read it carefully in order to acquire a complete understanding of a shroud line.

Look closely at figure 126, which shows shroud lines laid out ready for marking and cutting. A complete set of lines is marked and cut in a single operation so that the tension will be evenly distributed over all lines.

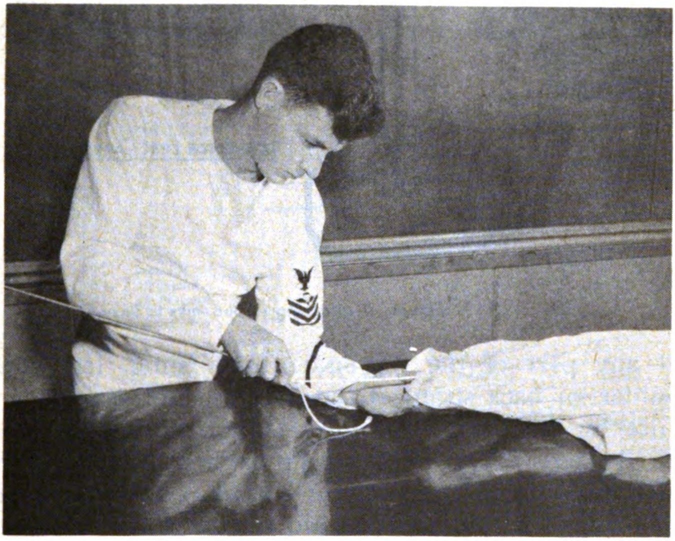


Figure 127. — Operator installing shroud lines.

In figure 127, shroud lines are shown being inserted in a 24-foot canopy. The operator is pictured using BOIKINS, or long, needle-like instruments used to carry each line through the proper shroud line channels. We know that the shroud line is continuous from link to link, and in figure 128, a detailed drawing is shown of the method of attachment of shroud links to links.

HARNESS

Harness replacement may be accomplished in a major overhaul shop or loft having heavy-duty machines, such as the 97-10 or the 7-31.

All harnesses must be replaced after two and one-half years of service, although replacement prior to the maximum age limit is made if conditions warrant.

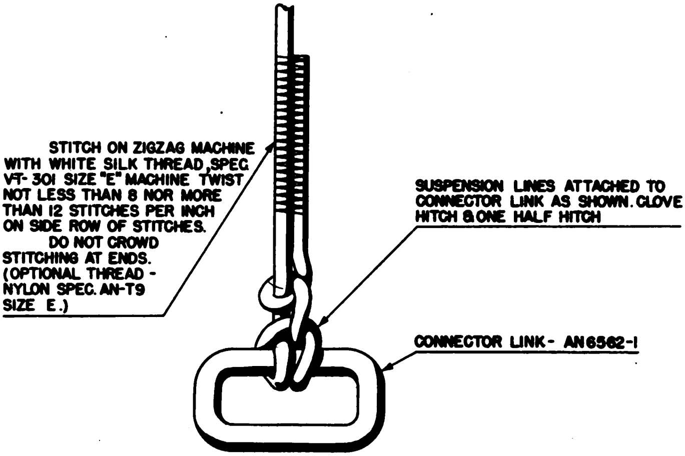
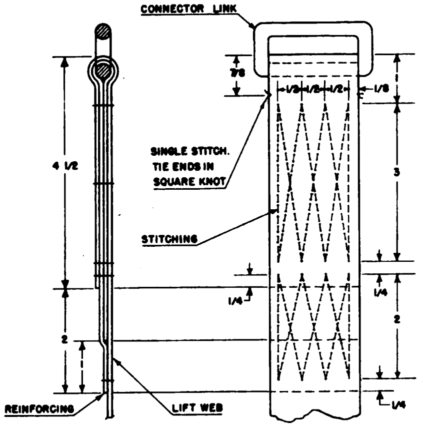

STITCH ON ZIGZAG MACHINE WITH WHITE SILK THREAD,SPEC VT-301 SIZE "E" MACHINE TWIST NOT LESS THAN 8 NOR MORE THAN 12 STITCHES PER INCH ON SIDE ROW OF STITCHES.
DO NOT CROWD STITCHING AT ENDS.
(OPTIONAL THREAD - NYLON SPEC. AN-T9 SIZE E.)
SUSPENSION LINES ATTACHED TO CONNECTOR LINK AS SHOWN. CLOVE HITCH & ONE HALF HITCH
CONNECTOR LINK - AN6562-1

Figure 128. — Method of attaching shroud links to links.

If any part of the WEBBING (main sling, leg, chest, shoulder, or back strap) of the harness shows evidence of failure by shearing, breaking, chafing, pulling apart, or other damage, the entire harness must be replaced. Webbing is not patched for obvious reasons — a torn webbing patched with a new strip would be too stiff and, in all probability, would fail to meet tensile strength requirements.

To replace a standard NAF (fixed type) harness, such as the SS or SB, the old harness is removed by cutting at the links. The suspension lines are not disturbed, and care should be taken not to accidentally sever the lines. Save hardware from the old harness — innumerable uses for such items exist in slings, hoists, tie-downs, and so forth.

During the change, the parachute should be completely laid out. Be careful not to turn the free links over, and be certain to place them in such position that they may be consecutively taken up. Examine the new harness, checking for twists in the webbing and hardware. In attaching a new harness, make certain that the risers contain no twists. In examining for such twists, begin at the center line of the main sling (between the leg straps) and trace the webbing to the end of the risers. A 12-inch strip of webbing is used as chafing gear at the links to prevent wear on the risers at that point. This chafing webbing may be Type VI, VIII, or X, depending on which is available. Type VI webbing is preferable since it is not as heavy as other types, thus rendering sewing easier and eliminating the possibility of a bulky joint.



NOTES:
1. STITCHING TO BE WITH 6 PLY COTTON THREAD SPEC. AN-T-46, TYPE II, STYLE A, OR 6 PLY LINEN THREAD, SPEC. V-T-291, TYPE B. STITCHING TO BE NOT LESS 4 NOR MORE THAN 6 STITCHES PER INCH.
2. ALL STITCHING SHALL BE IN ACCORDANCE WITH SPEC. DDD-S-751, TYPE 301. ENDS OF ALL STITCHING SHALL BE BACKSTITCHED A DISTANCE OF NOT LESS THAN 1/2 INCH.
3. LIFT WEBS ARE TO BE ASSEMBLED IN PAIRS WITH EXPOSED ENDS FACING.

Figure 129.—NAF drawing showing method of attaching lift webs to connector links.

In figure 129 is shown the latest method of attaching lift webs to connector links. Notice that the sewing is entirely different from the past "three box X" sewings. This new method eliminates sewing directly across the webbing at 90 degrees to the long edge. It has been found that sewing directly across the webbing greatly weakens the material.

When the risers have been tacked in place through respective links, check the rotation of the suspension lines. making certain no twists exist. Then make the sewings.

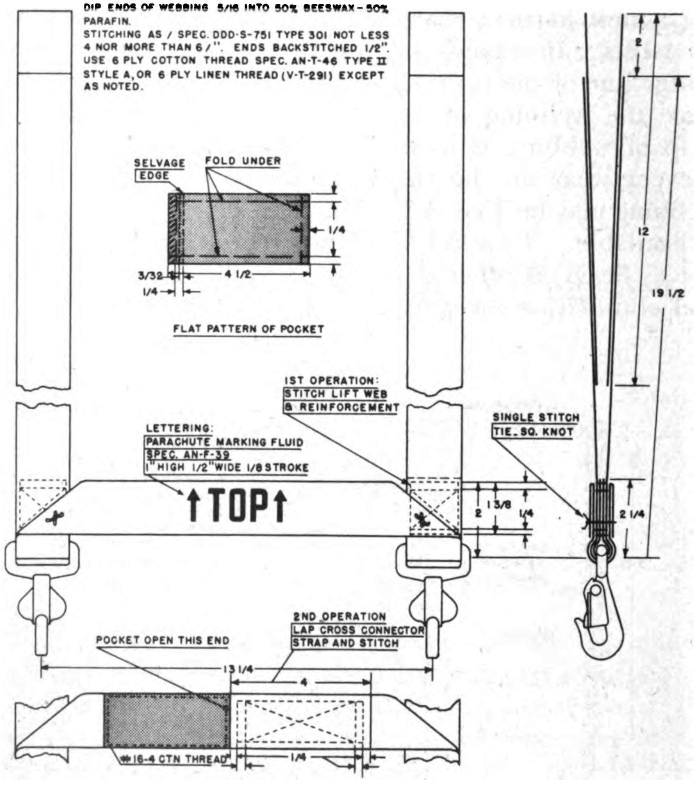

DIP ENDS OF WEBBING 5/16 INTO 50% BEESWAX-50% PARAFIN.
STITCHING AS / SPEC. DDD-S-751 TYPE 301 NOT LESS 4 NOR MORE THAN 6 / ". ENDS BACKSTITCHED 1/2". USE 6 PLY COTTON THREAD SPEC. AN-T-46 TYPE II STYLE A, OR 6 PLY LINEN THREAD (V-T-291) EXCEPT AS NOTED.
SELVAGE EDGE
FOLD UNDER
1/4
3/32
4 1/2
1/4
FLAT PATTERN OF POCKET
1ST OPERATION: STITCH LIFT WEB & REINFORCEMENT
LETTERING: PARACHUTE MARKING FLUID SPEC. AN-F-39 1" HIGH 1/2" WIDE 1/8 STROKE
↑TOP↑
SINGLE STITCH TIE. SQ. KNOT
2
12
19 1/2
2
1 3/8
1/4
2 1/4
2ND OPERATION LAP CROSS CONNECTOR STRAP AND STITCH
POCKET OPEN THIS END
13 1/4
4
#16-4 CTN THREAD
1/4

Figure 130. — QAC lift web assembly.

The LIFT WEB ASSEMBLIES of QUICK ATTACHABLE parachutes are secured to the links of respective canopies in the same manner as risers or lift webs are secured to a harness. In changing lift web assemblies, care must be taken to ascertain that the QUICK CONNECTOR SNAPS on a QAC assembly are facing in the proper direction so that the canopy name plate will be UP when the chute is packed.

Six-cord linen or cotton is used for harness sewing. Figure 130, an NAF drawing of the QAC Lift Web Assembly, furnishes a good over-all picture of the elements to be taken into consideration when working with webbing. Notice particularly the specified number of stitches per inch used on this assembly; the specification is the same for all heavy webbing sewings.

HAND SEWING WEBBING

When no applicable sewing machine is available, it is possible to sew webbing by hand.

The method is really very simple. One continuous thread or cord is threaded with a needle at each of its ends. One needle is started and drawn through the webbing until the center of the thread has been reached and the two needles are equal distances apart. Stitches of any length may be made, but in hand-sewing, the stitches per inch are to be the same as in machine-sewing. When making each stitch, be careful not to pierce the thread. One method of obtaining neat, even stitches is to first mark out in pencil the course to be followed.

In making each hole, an awl will facilitate the passage of both needles, and a sewing palm and pair of flat-nose pliers will also be of help.

This type of stitching is by no means a lock-stitch, but if made properly and drawn reasonably tight, it will prove satisfactory.

WAXING

Immediately after the webbing has been cut and before the ends are secured in place, the ends should be dipped in a mixture of 50 percent beeswax and 50 percent paraffin to prevent fraying. The wax mixture must be very hot, otherwise the wax will not penetrate the webbing. Blueprints state that 1-3/4-inch webbing must be dipped to a depth of 5/16-inch.

The reconditioning of parachute containers may be accomplished wherever an applicable sewing machine is available.

Prior to making repairs, it may be necessary to remove the container from the harness or lift web assembly. In such case, the remainder of the chute is secured in a chafing bag.

For tears and rips in container fabric, use a single outside patch. Before applying the patch, trim and baseball-stitch the tear with #16 x 4 or #30 x 3 cord.

The size and overlap of the patch should be consistent with good judgment. Cut the corners of the patch at 45-degree angles in order to stitch at the points and prevent curling-back and eventual tearing out of the entire patch. Use thread similar to that employed in the manufacture of the container. If the unit is an NAF container, you should use #16 x 4 aircraft gray thread, eight to 10 stitches per inch.

When a container tear crosses a stiffener, remove the stiffener before starting to make the repair. If a tear is in the false bottom, the bottom must be removed and probably replaced if the hesitator loops have been disturbed.

When the container frame has chafed through the corners where reinforcing webbings are located, the false bottom and frame must be removed before an efficient job may be performed. The webbing used is Type VI cotton or linen. Herringbone tape is never used for this purpose.

Should stitches securing hesitator loops break, as shown in figure 131, they may be repaired by hand sewing. A needle and thread (#30 x 3), plus a few round stitches will effect a secure repair. It is not necessary to stitch entirely through the false and main bottoms of the container.

All repairs to the container are accomplished with canopy and suspension lines as far as possible from the container. Whenever a repair is made to a parachute sub-assembly, and it is not necessary to disengage the part, THE CANOPY AND SUSPENSION LINES MUST BE PROTECTED, either by stowing in a clean chafing bag or by placing them on a clean tarpaulin.

A badly bent container frame must be removed and straightened before the container may be used again.

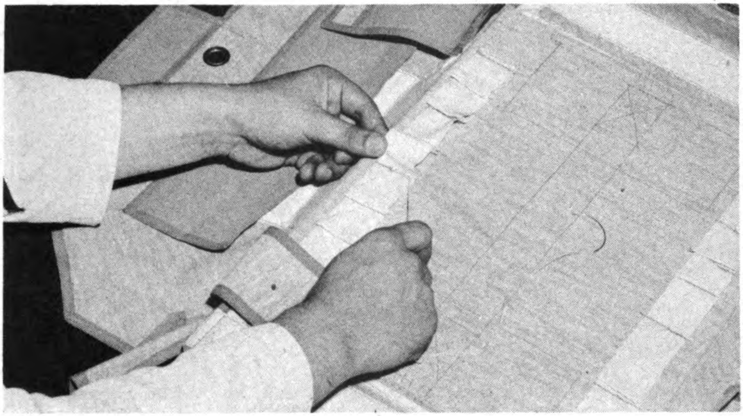


Figure 131. — Hand sewing loose hesitator loops.

GROMMETS

The replacement of grommets involves considerable thought and caution. It must be remembered that these units are of a special type, the same holding true for the setting tools. It is absolutely necessary that these grommets be properly set, since much of the smooth free motion of pack-opening depends upon these pieces of hardware.

In removing a defective grommet, care must be exercised not to tear the fabric. An excellent tool for grommet removal is a sharpened screwdriver. As illustrated in figure 132, by working around inside the washer and pushing back the crimped section of the grommet, eventual release is possible.

Damaged grommet holes may be reinforced with similar material, for example, tape or webbing, depending on the purpose and size of the grommet. Renewal of the sub-assembly, rather than reinforcement, is the recommended procedure to follow when a damaged grommet hole is located in a parachute container.

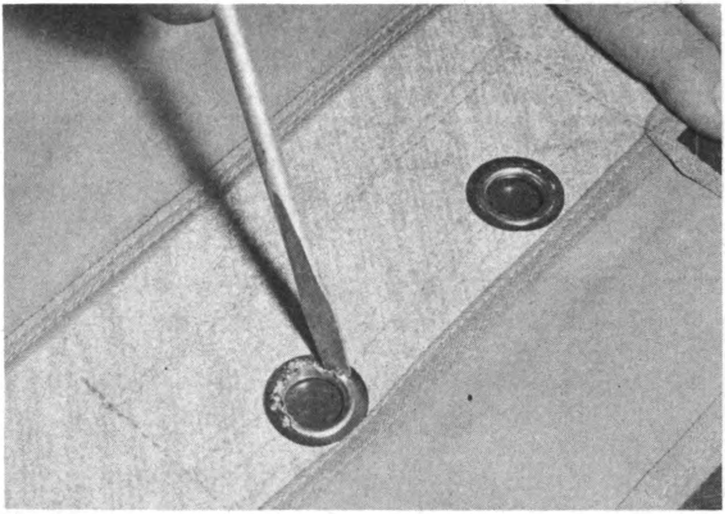


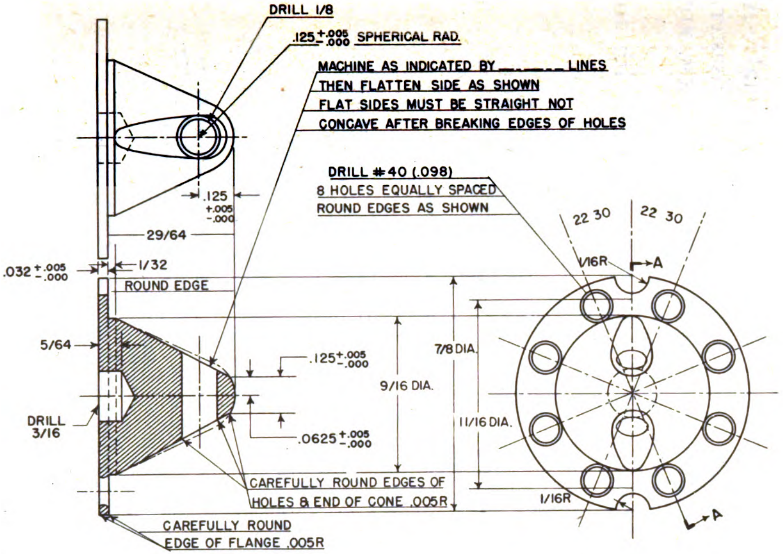
Figure 132. — Removal of defective grommet.

LOCKING CONES

A locking cone seldom needs re-attachment, but should such a step prove necessary, #30 x 3 thread, doubled and waxed, should be used.

A badly burred locking cone must be replaced, since removal of the burr would also cause removal of the plating.

When one cone is turned so that the locking pin hole does not properly line up with other cones, removal and re-attachment is required. The neatest sewing job is performed when the locking cone stiffener flap is first removed, the cone attached, and the flap again sewed down. However, it is permissible to sew completely through all thicknesses without removing the locking cone stiffener flap. Thread and securing knots are on the reverse side when the latter method is used. Figure 133 is an NAF drawing of the latest type locking cone.



NOTES:

1. FINISH: CHROMIUM PLATE SPEC. AN-P-39 TYPE I TOTAL THICKNESS NICKEL AND CHROMIUM, OR COPPER AND NICKEL AND CHROMIUM .00025 MIN.

		311394-1	CONE	7/8 DIA. X 1/2	BRASS	QQ-B-611 COMP B	1/2 HARD		SEE NOTE		
NO REQ	ASSEM.	PART NO.	NAME	STOCK	MATERIAL	SPEC.	HT. T	DESIGN U.T.S	FINISH	EST. WT	ACT. WT
PARACHUTE		←DESIGN FOR	DIMENSIONS ARE IN INCHES, LIMIT ±.005 DECIMALS ±.010 ANGLES ±1/2° *Unless otherwise noted.*								

CONE
PARACHUTE PACK RELEASING

Figure 133. — Locking cone.

CONTAINER EYES

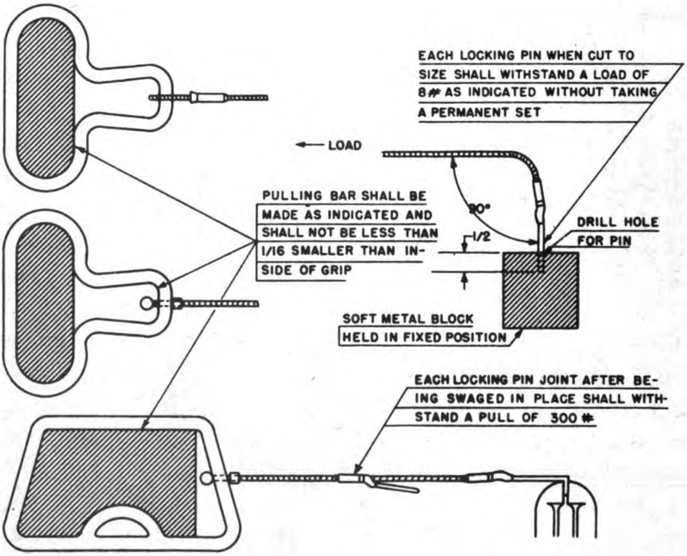
Renew container eyes and secure the points for container-opening elastics whenever they become damaged. Frequently container eyes merely fall from or are pulled out of the fabric. In the latter instance, a reinforcing patch will be required prior to re-attachment.

RIP CORD ASSEMBLY

When a rip cord is damaged, the best policy is renewal. If but one or two cable strands are broken, they may be sweat-soldered into position.

A bent locking pin cannot be straightened with a hammer without damaging (crystallizing) the metal. A broken locking pin in a locking cone will spell disaster. BENT LOCKING PINS SHALL BE RENEWED WITH A NEW RIP CORD ASSEMBLY RATHER THAN STRAIGHTENED.

If the cable shows signs of rust, wipe it clean with an

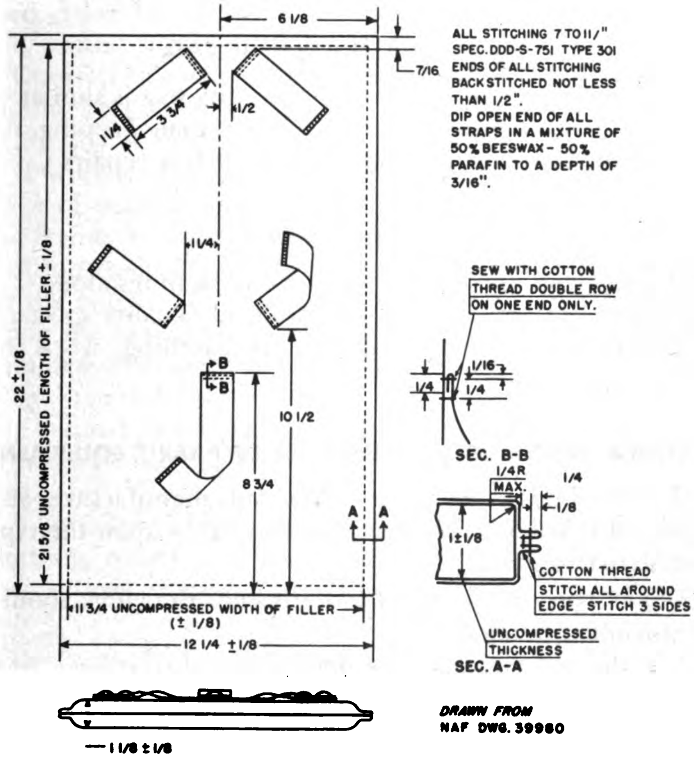

EACH LOCKING PIN WHEN CUT TO SIZE SHALL WITHSTAND A LOAD OF 8# AS INDICATED WITHOUT TAKING A PERMANENT SET
LOAD
PULLING BAR SHALL BE MADE AS INDICATED AND SHALL NOT BE LESS THAN 1/16 SMALLER THAN INSIDE OF GRIP
90°
1/2
DRILL HOLE FOR PIN
SOFT METAL BLOCK HELD IN FIXED POSITION
EACH LOCKING PIN JOINT AFTER BEING SWAGED IN PLACE SHALL WITHSTAND A PULL OF 300 #

DRAWN FROM
NAF DWG. 311527

Figure 134. — Method of testing locking pins.

oily cloth. Carefully burnish rusty locking pins with fine emery or crocus cloth, then apply a SMALL quantity of petrolatum, using a clean cloth to remove excess lubricant.

Recent types of rip cord assemblies, locking pins, and cable-to-hand-pulls have been SWAGED-FITTED similar to most aircraft control cables. While this process involves the use of special and expensive machinery, a very secure fitting is obtained. Figure 134 is an NAF drawing of the method used for testing locking pins.


6 1/8
7/16
1/2
3 3/4
1 1/4
1 1/4
B
B
10 1/2
8 3/4
A
A
22 ± 1/8
21 5/8 UNCOMPRESSED LENGTH OF FILLER ± 1/8
11 3/4 UNCOMPRESSED WIDTH OF FILLER
(± 1/8)
12 1/4 ± 1/8
1 1/8 ± 1/8
SEW WITH COTTON THREAD DOUBLE ROW ON ONE END ONLY.
1/16
1/4
1/4
SEC. B-B
1/4R MAX.
1/4
1/8
1 ± 1/8
COTTON THREAD STITCH ALL AROUND EDGE STITCH 3 SIDES
UNCOMPRESSED THICKNESS
SEC. A-A

ALL STITCHING 7 TO 11/"
SPEC. DDD-S-751 TYPE 301
ENDS OF ALL STITCHING BACKSTITCHED NOT LESS THAN 1/2".
DIP OPEN END OF ALL STRAPS IN A MIXTURE OF 50% BEESWAX - 50% PARAFIN TO A DEPTH OF 3/16".

DRAWN FROM
NAF DWG. 39980

Figure 135. — QAC back pad.

BACK PADS AND SEAT CUSHIONS

Back pads become quite frayed where tackings are continually broken and retacked. The new quick-fit harness should eliminate much of such wear, since they are not tacked to the back pad. Occasionally, a KEEPER will pull off and require repair, but, as may be seen in figure 135, the QAC back pad will offer little maintenance trouble.

Seat cushions usually fray at the corners, the points of attachment to the parachute pack. If the seat cushion has been torn loose or requires repair, the parachute will have to be "cracked" before the repaired cushion may be returned to position. NEVER TACK A CUSHION TO A PACKED PARACHUTE.

PARACHUTE TRAVELING BAG

The procedure in repairing a traveling bag is similar to that used in container repair. Other than keeping the bag clean, this unit requires extremely few repairs.

FLIGHT GEAR

Repair work applies to more than parachutes alone. A Parachute Rigger is also responsible for FLIGHT GEAR repair — a general term referring to clothing worn by aviation personnel.

MANUFACTURE AND MAINTENANCE OF FABRIC EQUIPMENT

The methods used in the laying out, manufacture, and repair of fabric equipment depend entirely upon the type and shape required.

When possible, as has been stressed, drawings should be consulted for details.

Use the old cover as a guide when fabricating a new one. In some cases it may be necessary to make a drawing from which paper patterns may be cut.

When sewing large sections, covers, and so forth, where a lap seam is to be exposed to the elements, the external edge of the area should be toward the bottom (unless vertical) to permit water to flow over the seam without obstruction.

SECTIONS OR COVERS

The first step in manufacturing sections or covers is the determination of the length of each strip and the number of strips required.

Strip-length is measured in feet, while the number of strips is obtained by dividing the width of the panel by the width of the strips. The standard width for cloth and duck is 36 inches; for artificial leather it is 50 inches.

Allowance must be made for seams and hems in all calculations. For the average-size hem where fasteners are used, 1-1/2 to two inches must be allowed in both length and width.

Covers to remain attached while the plane is in flight should be constructed so that warp threads are parallel to the air stream.

If stiffener frames are to be placed in covers, an extra piece of material, approximately three inches larger than the frame, must be laid over the top of the cover at the position desired, and the inside of the frame marked off on the patch. The patch is then carefully machine-sewn along the pencil-mark, and the material within the seam trimmed out, allowing a 1/8-inch margin all around. The three-inch flap is turned to the opposite side and the flap pinned to the cover, allowing no wrinkles to remain. A machine-seam is then made as near as possible to the flap.

The tailored buttonhole is used for small openings on clothing, covers, sections, bags, and so forth, where grommets or eyelets are not practical.

COCKPIT COVERS

To obtain proper measurements for material and to provide for ease in attachment, lift-the-dots of machine-screw type are installed around the cowling approximately one-half inch from the upholstery.

The first post is placed on the center line of the cockpit at its leading edge, the next on the center line at the rear of the cockpit. Other posts are placed six to seven inches apart. With posts in place, measurements may be taken for the material, and necessary allowances made for seams and hems.

A Type LSc-2 seam should be used for joining panels together, although one panel is usually sufficient because of the narrow width of the cockpit.

The material is placed over the cockpit with the warp threads parallel to the line of flight. In order to obtain a cover free of puckers and wrinkles, a hole is punched in the front of the piece to hold it temporarily in place on the post. The cover is then drawn just enough to hold it taut, and a hole punched in the cover for the rear post. Remaining holes may then be punched alternately from side to side. When this operation is completed, the cover is removed and a line drawn around the edge, clearing the holes by 3/4-inch.

The material is folded and stitched on this line with a Type EFb-2 stitch. The holes punched in the cover indicate points for the installation of lift-the-dot fasteners. Dots on fastener sockets are placed at the outer edge of the cover, and will function in no other position.

ENGINE COVERS

In laying out an engine cover, a sketch should be made showing diameter, circumference, and depth of the engine. Careful judgment must be used in making the opening so that the cover can be readily put on and removed. It is important that the cover fit snugly so that it will not be blown off by wind. Proper security may be obtained by the careful application of glove, lift-the-dot, or turn-button type fasteners.

BOOTS OR SOCKS

A BOOT OR SOCK is used for protection against dirt and grease on such units as tail-post fittings, rods, and so forth. Duck is used for all outside types of boots or socks, while either airplane fabric or duck may be used for the inside type.

Boots are attached either by lacing through grommets or by stitching.

BOMB-BAY CURTAINS

Because of the many projections encountered, extreme care must be taken in making this curtain. Whenever possible, the old piece should be used as a pattern. If the material requires piecing, Type LSc-2 or LSc-3 lap seams should be used.

The outer edges of the curtain are stitched, and all projection holes are reinforced with russet or horsehide leather. Number 0 or 00 grommets are placed at two-inch intervals in the hem for lacing to the bomb-bay. Slide fasteners with double-pull sliders are often used for required openings.

SUNLIGHT

Sunlight WEAKENS silk fibers. Tests conducted over a five-week period of constant exposure to sunlight have indicated that the strength of the silk fibers may be reduced as much as 50 percent. Effects of sunlight on nylon are undetermined. Nevertheless, A PARACHUTE SHOULD NOT BE HUNG OUT OF DOORS WHERE DANGER OF EXPOSURE TO DIRECT SUNLIGHT EXISTS.

SALT WATER

SALT WATER IS EXTREMELY INJURIOUS TO SILK. Nylon parachutes are not affected to any important degree by limited immersion in salt water. All parachutes should be thoroughly rinsed in fresh water immediately following contact with salt water. Salt water will reveal itself in brownish areas on the canopy, in which case the cloth is almost certain to be damaged.

After soaking in fresh water, suspend the canopy and shrouds at full length in some convenient location OTHER THAN THE LOFT OR DRY LOCKER where other chutes may be hanging. Do not hang them in the sun. Never wring a parachute with your hands or run it through a mechanical wringer. Simply allow it to drip dry.

BATTERY ACID

Battery acid is detrimental to parachute cloth or any other fabric. Battery acid stains appear as irregular ash-gray or dead-white spots. Such stains are clearly evident on the pack, but are sometimes difficult to locate on the harness and canopy.

If careful inspection discloses a suspected portion of fabric, run your fingers gently over the spot, pressing it lightly. If acid has been in contact with the fabric, the fibers will tend to break when slight pressure is applied and, if the chemical action has progressed far enough, the fabric will powder and fall apart at your touch. If the affected area is small, it may be trimmed out and patched, but in such case make certain that the ENTIRE affected area is removed.

When acid or ammonia (alkaline) stains are detected in a canopy, the chances are that other areas have been similarly affected. One must be careful to check thoroughly, making absolutely certain that all acid-stained areas have been eliminated. DO NOT PERMIT ONCE-CONTAMINATED CHUTES TO COME IN CONTACT WITH OTHERS, AND NEVER PACK A SUSPECTED CHUTE FOR SERVICE UNTIL ENOUGH TIME HAS ELAPSED FOR ANY OVERLOOKED AREA TO REGISTER POSITIVE REACTION. As stated before, ANY DOUBTFUL STAIN SHOULD BE TESTED WITH LITMUS PAPER FOR ACID OR ALKALINE CONTENT.

When large or numerous acid-affected areas are discovered in a canopy or harness, TURN THE ASSEMBLY INTO A MAJOR OVERHAUL STATION.

OIL, GREASE, GASOLINE, ETC.

A parachute is very apt to become stained with oil, grease, gasoline, or hydraulic fluid for the simple reason that it is often exposed to those substances while being worn or stowed in an airplane.

Oil is far more injurious to silk than to nylon. Oil may be removed by washing the affected area in cold, fresh water with Navy-issue castile or a high-grade commercial soap. All traces of soap must be thoroughly rinsed from the material.

Small oil stains may be successfully removed from silk or nylon by washing in cold water. When large areas of silk fabric are stained with oil, the affected portions must be removed and replaced with new material. This is a major overhaul job.

Grease and gasoline stains are removed in the same manner as oil stains.

Washing a chute is neither possible nor feasible—the chute must be dry-cleaned. VM and P Naphtha are excellent dry-cleaning fluids when properly used. All cleaning should be performed in a well-ventilated room or in the open air, and the hands should be adequately protected.

NEVER USE BRUSHES TO CLEAN SPOTS ON THE CANOPY, and do not rub or twist material between the hands. Merely soak the fabric and gently stroke the dirt loose with a soft, absorbent cloth.

DIRT

Mud, dust, or dirt will not ordinarily harm a parachute if such elements are immediately washed out. Use cold water and soap if the fabric is badly soiled If mud has caked on the material, DO NOT BRUSH THE SURFACE. Soak the area in water until the mud works free. Dust is removed by shaking.

MILDEW

Mildew is a fungus growth — a tiny plant thriving in dark, humid places. To prevent mildew from injuring the parachute, KEEP THE ASSEMBLY DRY AND CLEAN. This holds especially true in warm, humid climates.

Keeping parachutes dry is a real problem, and tight lockers or bins are great helps in this regard. When these bins are equipped with containers for dispensing NAPHTHALENE FUMES, they are particularly effective.

Once mildew begins to grow, it leaves a tell-tale trail. The spot may be pale green, pale blue, gray, or cream in color, or a combination of all such hues. A mildew stain is not easily overlooked and, unless the affected area is immediately treated, the fungus growth will spread and quickly destroy a parachute.

Nylon is not as susceptible to fungus growth as silk. When traces of mildew are found, wash the affected area thoroughly in cold water, using a high grade of mild soap. If mildew is found in one chute, all others should be checked.

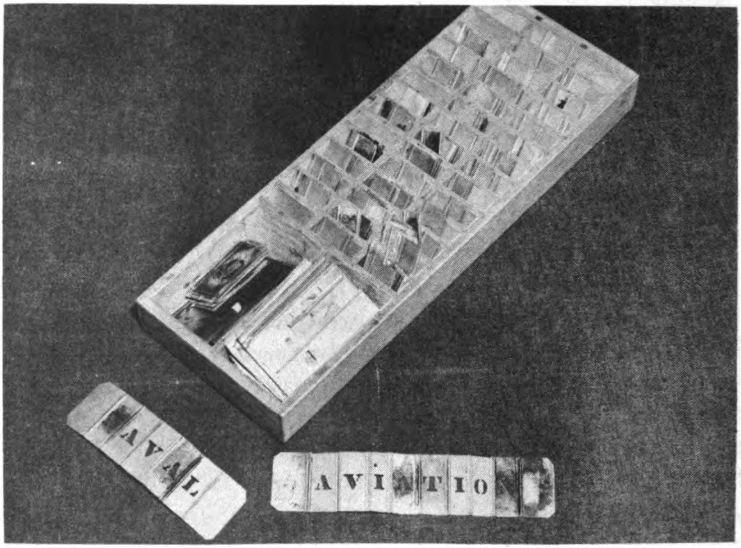


Figure 136.—Adjustable metal stencils.

STENCILING

Parachute canopies, pilot chutes, harnesses, packs, and so forth, are marked for identification and scheduling purposes. Since a metal tag cannot be riveted to each section, a marking fluid non-injurious to fabric is used. Such non-fading marking fluid must conform to Specification AN-F-39, which demands that the fluid be both permanent and harmless. NEVER USE ORDINARY INK as it contains harmful ingredients.

The parachute is marked as stipulated in the General Specification for parachutes.

STENCILS

Several types of stencils are at your disposal. One is the metal adjustable type made in sizes of from one-half to two inches as shown in figure 136.

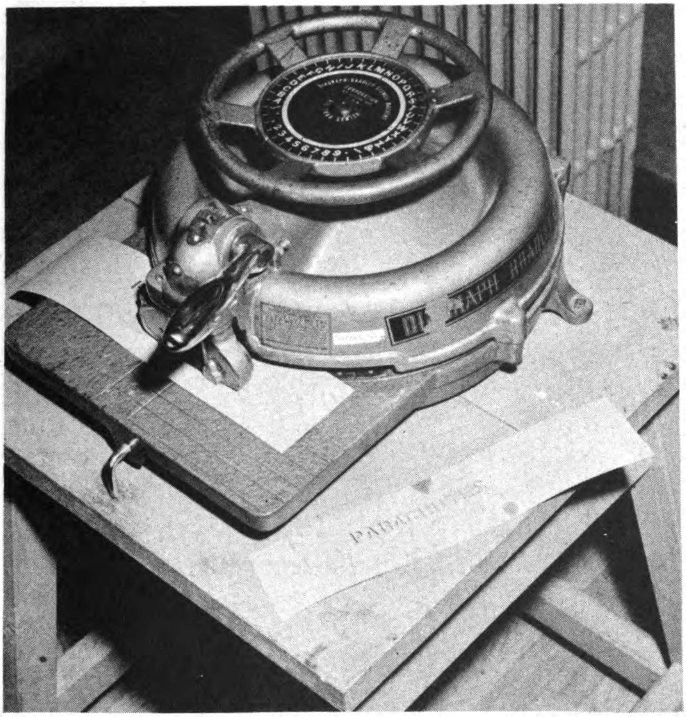


Figure 137.—Diograph Bradley stencil machine and stencil.

When using adjustable metal stencils, exercise care that the letters and numerals do not shift and leave a wavy line.

Another type of stencil is that cut from stiff fibrous paper, illustrated in figure 137. THIS MACHINE MUST NEVER BE USED TO CUT METAL.

A third type of stencil is a simple rubber or metal stamp for stationary marking. This means that the information contained in the stencil is not changed each time a particular item is marked. This unit is pictured in figure 138.

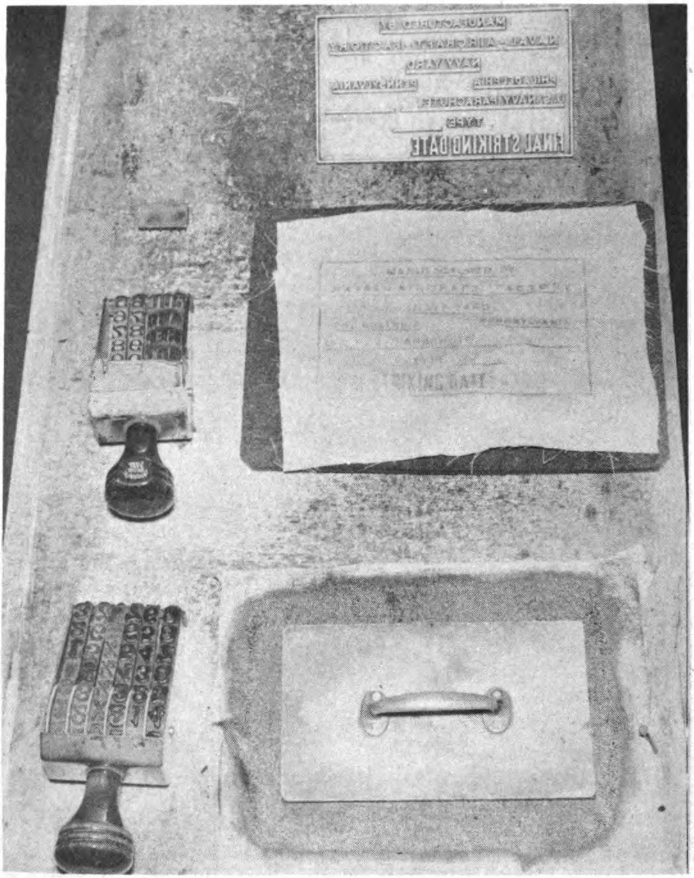


Figure 138. — Stamp used for marking parachute name plates.

MAKING A STENCIL

To stencil a unit, place a flat 1/4-inch felt cushion under the area to be marked, stretching the material so as to remove wrinkles. Place the stencil firmly on the material. Rub the stencil brush over the ink pad; work out excess ink, and apply the brush to the stencil, working the ink thoroughly into the material. Remove the stencil carefully so as not to snag the cloth or smear the lettering.

Each time a parachute container is changed, the corresponding canopy serial number should be applied.

QUIZ

1. What publications give you the construction information you need for parachute repair?
2. What information does this set of symbols give you?

301-OSd-2

3. What do these symbols mean?
   - *a.* SS.
   - *b.* EF.
   - *c.* LS.
   - *d.* BS.
4. Is it necessary to send a parachute to an overhaul station for
   - *a.* harness replacement?
   - *b.* repair of an eight-inch hole in the canopy?
   - *c.* repair of damage to harness webbing?
5. In what direction do warp threads run in a fabric?
6. *a.* When a double patch is used to repair a tear, which patch is applied first?
   b. When only one patch is used, on which side is it applied?
7. What is the standard established total length of a cut shroud line?
8. What implements would you recommend for the construction of a seat-type parachute pack?
9. What are the reasons for waxing thread?
10. When making a parachute container why is it necessary to prevent the aircraft gray side of the cotton processed fabric from facing inside the container?

11. Which of the following types of repairs are major repairs and which are minor?
    - *a.* replacement of canopies.
    - *b.* replacement of a section of a canopy.
    - *c.* replacement of a vent collar.
    - *d.* replacement of a pilot chute.
12. What is the treatment for a soiled pilot chute connector cord?
13. Under what conditions would a two-inch tear represent a major repair?
14. What size and type of thread should be used for stitching inside and outside patches?
15. By how much will a second sewing in the same area of a shroud line reduce the tensile strength of the shroud line?
16. What is the most effective tool for grommet removal?
17. What is the standard width of cloth and duck? Of artificial leather?
18. What is the effect of sunlight on silk and nylon?
19. How would you remove small oil stains from silk or nylon?

APPENDIX I

NOMENCLATURE OF PARACHUTES

A DESCRIPTION OF TERMS USED BY PARACHUTE PERSONNEL

Accordion pleats. — Double folds, placed in the fabric of the canopy, which conform to the size and shape of the container.

Adaptor. — Forged metal fittings through which the webbing of the harness passes, and positioned to maintain adjustment of the harness.

Apex. — Highest point; peak of the canopy.

AR-8. — A droppable rigid lifeboat carried under the aircraft wing. This lifeboat uses eight standard canopies in a cluster for descent.

Attached Type. — This container is attached to some part of the aircraft, not to the harness. Cargo or aerial delivery chutes are sometimes of this type.

Anti-spin chute. — A small parachute used to correct or prevent spins in aircraft.

Auxiliary parachute. — The secondary chute used with training units.

Auxiliary strap. — Two adjustable webs forming shoulder, chest, and back straps, used to retain the wearer in the sling.

Awl. — Small hand tool used to make holes in leather or webbing for hand sewing.

Back cushion. — A formed pad, placed between the wearer's back and the parachute harness, fitted with retainer flaps for positioning the webbing of the harness.

Back pack. — A parachute packed in a container of a type to be attached to the back of the harness.

Back strap. — Formed by two adjustable, overlapping webs, such terminating at an adapter. — Positioned to pass across the small of the back.

Bail out. — To leave an aircraft with a parachute while in flight. To jump out of, or leap from, an airplane.

Barometric release. — A release device for parachutes, designed to release the chute at any predetermined altitude. If release is used below the pre-set altitude, the parachute automatically inflates. First developed by Germany and used to drop wounded personnel from bombers. Used at altitudes at which oxygen deficiency may cause unconsciousness before a safe minimum height is reached.

Baseball parachute. — A formed canopy, cloth-cut and sewn as on a baseball cover. Used for dropping mines.

Berry, Albert, Captain, U.S. Army. — In March, 1912, made the first successful parachute descent from an airplane at Jefferson Barracks, Missouri.

Bias. — A cut or seam running obliquely across the threads of a fabric. This adds materially to the initial strength of the fabric and increases the "time lag" as well as confining tears or blow-outs to particular sections of the gore.

Blanchard, J. P. — In 1785, constructed, in England, a parachute attached to a basket, using dogs as cargo. His calculations for a man-carrying chute were inaccurate.

Bombyx mori. — A cultivated silk-producing moth from which ordinary commercial silk is derived.

Botrktis bassiana. — A fungus growth within the caterpillar, commonly called "silkworm rot," which causes the fatal silkworm disease known as "Muscardine."

Bowline knot. — The knot used for attaching the bridal cord to the apex of the canopy.

Box "X" stitching. — A type of stitch formed in the shape of a box, with a cross "X" running to each of the four corners.

Brake chute. — A ribbon-type parachute used to reduce the speed of extremely high-speed airplanes to permit landing or bailing-out.

Bread board knife-type release. — A slotted board with a slot lengthwise with knife hinged in one end, and a pull-cord at the other end, used to release parachutes from free balloons during early exhibition jumps.

Bridal cord. — Cord from apex of canopy to pilot parachute, sometimes called the pilot-chute connector cord.

Breathe. — A continual fluctuation of the entire canopy during descent. It may or may not be present in a canopy in all descents, indicating that its presence is partially due to wind and weather conditions.

Broadwick. — Miss Tiney Broadwick is credited with making the first free-fall parachute descent, using a knapsack-type container invented by her father.

Broken picks. — A broken filling yarn, usually appearing as a streak along the fabric.

Bungee. — Called "Athletic Cord," or "Sampson Cord." An elastic cord composed of square strands of rubber and covered with cotton in a plaited weave.

Burst test. — A method of testing material by placing pressure on both warp and weave of material until rupture occurs.

Butterfly. — (See REINFORCEMENT TAPE).

Canopy. — Main fabric body of the parachute which, when filled, offers resistance to a falling body.

Cargo chute. — All parachutes so designed and used for lowering all objects other than pilot or passengers are known as "cargo" or "delivery-type" chutes. These vary in size, shape, design, and composition according to requirements of the weight of the articles to be lowered. Cargo chutes are as a rule of the attached type, and all are mechanically operated.

Caterpillar club. — Membership restricted to those who have made an emergency parachute jump.

Chafing webbing.— Short pieces of webbing used to prevent chafing. Sewed between main lifting webbing and connector link; on pack tray, and so forth.

Chain. — (Shroud lines). A method of shortening lines for stowage; prevents entanglements.

Chair type. — Designed for passengers' use in cabin-type aircraft. Classified as C.B. or QAB types.

Chest strap. — Two webs, each in the form of a "V", connected across the chest of the wearer by a snap and V-ring. The snap should be in the LEFT web, thus eliminating the danger of connecting the snap with the rip-cord ring.

Chest type. — A parachute wherein the pack is attached to the front of the harness. For use in aircraft where the wearer must be unencumbered during normal flight operations.

Closing hook (Switlik). — A special hook used for closing that type of parachute in which the container cover is clamped to the tray by the rip cord.

Cocking. — Robert Cocking, an Englishman, built a parachute of unique construction in an attempt to eliminate the oscillations present in the Garnerin design.

CO_2. — Carbon Dioxide. Carbon anhydride compressed under high pressure in metal flasks and used to inflate pneumatic life jackets and rafts. One ounce of CO_2 (by weight) will buoy 35 pounds of dead weight. CO_2 is the product of combustion or oxidation; will not support combustion. Due to its weight and suffocating effect on release, it is used as a fire extinguisher.

Container. — Fabric envelope into which the canopy and cordage are packed.

Cord. — Various sewing threads — 9-cord, 6-cord, and so forth.

Cordage. — All shroud lines.

Corner flap. — Tabs on corners of containers to aid in retaining silk in container.

Crack. — The process of pulling the rip cord to open the container and release the canopy.

Cross-connector strap. — A "safety strap" or short length of webbing, secured to each lift web assembly group to prevent deflation or a complete streaming of the parachute canopy if only one web group was hooked to the harness in an emergency.

D-rings. — Metal fittings forged in the shape of the letter "D" with a double bar, formerly used as a connector link of shrouds to harness and, where "V" rings are now used. Drawing No. AN 6564-1 is a D-ring. A 5000-pound D-ring is now used on QAC harnesses, forming the female part of the quick connection.

Decelerate. — A free-falling body will decrease its rate of descent due to pressure of the atmosphere against its frontal area. This resistance will gradually increase as the falling body nears the earth due to increasing atmospheric pressure. (See TERMINAL VELOCITY).

Delayed-release jump. — A jump in which the wearer of the parachute delays pulling the rip cord in order to quickly lose altitude. Can be made only in an emergency. If premeditated, BuAer authorization is required.

Denier. — (Den-yer). A unit of measurement of silk in which the size of yarn is quoted as its weight per length. This is determined by weighing 9000 meters and quoting the size of the yarn in grams. Thus, if 9000 meters weigh 30 grams, the size of the yarn is then known as 30 DENIER. The higher the denier, the heavier the thread. Opposite to the system used in cotton threads.

Diagonal seam. — Lateral or cross-seams joining the sections of a gore. The diagonal seam lies at an angle of 45 degrees to the gore centerline.

Dip. — When the canopy or container and harness has passed directly between both groups of lines and not through any of the individual groups which would form a twist.

Double bottom. — An extra fabric bottom in the container to which the hesitators are attached; also forms inner cover for the wire container frame to separate metal from silk.

Draw load. — The load, expressed in pounds, required to start the expansion of a given material, such as the draw load of extendable lift webs or draw loads of Unolyn. In lift webs, as pounds per lift web; in cloth, as pounds per inch.

Drift. — The horizontal distance, measured on the ground, from the point immediately below the parachute when it inflates to where it first comes in contact with the ground.

Drop test. — Dropping a dummy from an aircraft or simulating a live jump, to prove the serviceability of a parachute.

Drop test connector link. — A temporary linkage used between the packed canopy for drop-testing (without harness) and the drop-test dummy. Permits drop testing of canopy without necessity of attaching a harness. (See QUICK-CONNECTOR LINK DROP TEST).

Dry locker. — A room where parachutes may be suspended by the peak for airing and drying. This requires an overhead of at least 32 feet. Generally referred to as "The Tower."

Dummy. — An object of set, or variable, weights, usually fashioned to represent the human torso, on which a parachute may be attached for testing. Should never be exposed to the air stream at speeds in excess of 150 m.p.h. (See PREMATURE OPENING).

Dummy (High-Speed). — A bomb-shaped dummy in which the canopy may be stored within the dummy, and suspended from the bomb rack. For use at speeds in excess of 300 m.p.h.

Flare chute. — Cargo type, with lightweight canopy of approximately 0.75-ounce fabric and a porosity of 340-500 cubic feet per minute. Extra long cordage. Used as support for a magnesium candle.

Flat-type parachute. — All service-type parachutes are of this order. Fabricated of gores the sides of which are cut straight.

Flotation gear. — All pneumatic lifesaving devices fabricated of a rubberized fabric using expanding CO_2 gas as a medium of inflation. (See LIFE RAFT).

Floats. — A place in the fabric where warp or filling yarns extend unbound over threads with which they should be interlaced.

Follow-through. — This is the comparison of tensile strengths of the various parts of a parachute to bring the ratio to one (1).

Formed canopy. — A canopy in which the gores are cut with convex sides. This type canopy will not lie flat or withstand the opening shocks of high speed required by military service.

Frame, container. — A rectangular wire frame enclosed in the bottom of the container to retain its shape.

Frame, pilot chute. — Similar to an umbrella frame; has four wire bows actuated in pairs by coil springs.

Free fall. — A jump in which the wearer releases his own parachute by pulling the rip cord. (Opposed to a static-line jump).

Free-type parachute. — A parachute attached to the wearer and free of any attachment to the aircraft, allowing the wearer to make his exit from any convenient position.

French serving. — A form of whipping used on shroud lines of pilot chute to form loop for point of attachment for parachute connector cord.

Garnerin. — Andre Jacques Garnerin was the first balloonist to consistently make demonstration parachute descents, and is credited with establishing the reliability of the parachute.

Gore. — That portion of the canopy contained between two adjacent radial seams. This area is triangular and consists of four sections in the service-type, and is bordered by two radial seams, skirt at periphery and vent collar at the peak.

Grommet (Plain and spur). — Metal eyelets, attached to one side flap of the container. Forms part of releasing device by fitting over locking cones, being secured in place by locking pins.

Guardian angel. — A parachute developed in 1917, weighing some 20 pounds, of attached type and formed canopy; unsafe at speeds exceeding 100 m.p.h.

Guide surface parachute. — A formed canopy in which the design is carried to an extreme. The opening at the skirt is about half the flying diameter. Shape of the inflated canopy is maintained by a series of internal lines.

Hand pull. — A metallic handle attached to the end of the rip cord cable, normally carried in a pocket on the left side of the harness, accessible to the wearer. The maximum allowable pull is 22 pounds.

Hand sewing. — Sewing with needle by hand, using the PALM.

Hardware. — Comprises all metal fittings used on parachute harnesses.

Harness. — An arrangement of linen, cotton, or nylon webbing straps with metal fittings for fasteners and adjustments designed to hold and support the wearer in an upright position when making a parachute descent with an inflated canopy.

Harris. — Lieut. H. R. Harris made the first emergency use of the free-type parachute at McCook Field, 20 October, 1922.

Heinecke. — This parachute, of German design, was the first to save the life of an airplane pilot in combat. This incident occurred in 1918, the jump being made from an altitude of 18,000 feet.

Hem. — Fabric folded back upon itself and sewn. The peripheral edge and peak of the canopy.

Herringbone. — A weave having reversals of twill such as used in cotton tape, Type I.

Hesitator loops. — Rubber bands or tape formed in rows on double bottom to retain suspension lines. Prevents fouling of cordage.

Hook. — Pack-opening elastic secured to ends of opening elastics. Engage in eyes for rapid opening of pack.

Hook-packing table. — A hook placed at the peak-end of packing table to position and hold under tension the peak of the canopy during certain phases of packing.

Hook-switlik. — See CLOSING HOOK.

Hooks, packing. — Metal, having a 3/16-inch shank and the appearance of an offset screwdriver with a rounded bit-end. Used to draw suspension cordage through hesitators.

Hoop tension. — The outward tension, or force, exerted against the canopy material. The tension exerted by the outward moving skirt or hem during opening.

Hot press (Kwik print — simplex or similar). — A machine for printing with metallic or pigmented foil on leather, wood, celluloid, and so forth, by use of heat and pressure.

Housing. — A flexible metal casing forming a protective means of carrying the rip-cord cable from hand pull to release mechanism.

Humidity. — Moisture content of air. Measured by percentage of saturation.

Hygroscopic (Hydroscopic). — Silk fibre is hygroscopic, meaning that it will take on or give out moisture depending on moisture content of atmosphere to which exposed.

Inherent stability. — The ability of a parachute to dampen oscillation. A built-in characteristic, controlled by the design. This is accomplished by placing the vent at the center of pressure and the ratio of projected area to shroud-line length.

Inspection flap. — Small reinforced flap, secured to side flap, forming a protecting cover for releasing device and enabling instant inspection of cones and pins.

Inspection tag. — Small card carried as a record in a pocket on the outside bottom of pack, containing the date, place, and packer's name upon each reconditioning or repacking of parachute.

Inter-sectional seam. — See DIAGONAL SEAM.

Irving. — Leslie Irving made the first premeditated free fall, using the free-type manually-operated parachute. (1918).

Jacket, life (Mae West). — A rubberized fabric vest-like jacket, pneumatically inflated by CO_2 or oral inflation.

Jump. — See BAIL-OUT.

Jungle kit. — A kit, arranged in the back pad or seat cushion, containing survival equipment. The para-raft kit has completely replaced this assembly.

Kapok. — The mass of silky fibres within the seed pods of a tropical tree (Ceiba Pentandra) of the Malay Peninsula, sometimes used as a cushion filler or for life preservers.

Keepers. — Short pieces of light webbing which hold the harness main sling to the pack in order to eliminate shifting of container.

Kostelsky. — A type of German ribbon parachute, designed for live jumps from high-speed aircraft.

Lap pack. — An early type parachute designed for photographers.

Life line. — Line from positive opener-type parachute to the harness. Single-point suspension. Secured to ring on chest of harness.

Life raft (Pneumatic). — An encircling, buoyant tube of rubberized fabric, oblong in shape, with a semi-pointed bow and fabric bottom. Inflated with CO_2 or oral inflation.

Lift off. — An early method of making a premeditated descent. A descent in which the jumper stood in the slipstream (usually on the wing), and pulled the rip cord.

Lift-the-dot. — A patented metallic fastener of four parts. The sole means of unfastening this device is to insert the finger beneath it and "lift the dot."

Lift web. — The unstitched part of webbing at each end of the sling. That part of the harness extending up and out from the sling in four directions to which the cordage is grouped. (See RISERS).

Line overs. — One or more shroud lines passing over the top of the canopy during inflation. This prevents complete inflation of the canopy.

Link, connector. — Forged rectangular-shaped metal fittings with rounded ends used to connect shroud lines to harness lift webs.

Lobe chute. — Invented in 1926, the canopy was 24 feet in diameter, of straight construction, skirt-panel formed, with no inter-section seam, thus forming a valve effect which permitted no excessive internal pressure. A very fast-opening chute.

Locking cone. — Small tapered metal dowels, forming the main female part of release device sewed to the cone flap.

Locking lever, attached. — A short, curved lever attached to the rip-cord cable. Its function is to form and position the male part of the release device on certain type chutes.

Locking lever, unattached. — Larger than the attached lever, furnishing greater leverage.

Locking pin. — Short corrosion-resisting steel pin swaged to rip-cord cable, inserted through locking cone, forms the primary male part of release device.

Manually-operated chute. — A parachute of a type whereby the releasing device is unattached to the aircraft and without mechanical means of release. The releasing device is attached to the harness of the parachute and is operated manually by the wearer.

Marking fluid. — A non-acid blue ink (Specification AN-F-39).

Mae West. — See LIFE JACKET.

Mechanically-operated chute. — A parachute not manually operated, employing a release device such as the quilter release, barometric release, or static line.

Mildew. — Fungi, mold caused by excessive dampness. A spoor-like spot running from pale green through pale blue to gray or cream in color.

Minimum altitude. — The lowest altitude at which a parachute can successfully function.

Mispicks. — A filling yarn improperly interlaced.

Name plate. — All pertinent data stamped on the No. 1 section of the top gore, used as a guide for rigging and packing. Name and identification data stamped on leather for attachment to flight clothing.

Nylon. — A synthetic protein-like product used as a silk substitute. Made of inorganic chemicals. Is less subject to mildew, has considerable elongation as compared with silk. The smooth, wire-like fibres cause less pore friction than that of silk. May be readily distinguished from silk, since it is slightly more transparent and has a soapy texture.

One-man raft. — A raft of sufficient size to support one man. Attached to parachute as survival equipment. (See LIFE RAFT).

Opening elastic. — (See PACK-OPENING ELASTIC).

Organzine silk (Warp threads). — Made by the union of two or more single threads, twisted separately in the same direction, doubled, then retwisted in the opposite direction. Thrown silk, used chiefly for warp. A fabric made of such thread.

Opening Cords. — See PACK-OPENING ELASTIC.

Oscillations. — The pendulum-like action of an inflated canopy during descent, with the apex relatively fixed, caused by the uneven distribution, or excessive internal pressure.

Pack-opening elastic. — Exercising cord (Bungee) with hook #212257-2 attached at each end. Used to expedite the opening of container upon release by rapidly removing flaps from pack.

Packing bar.— A metal or wooden bar, 22 x 1-1/2 x 3/16-inches, used for straightening pack when closing.

Packing card. — See INSPECTION TAG.

Packing hook. — See HOOK, PACKING.

Packing table. — A smooth surfaced table three feet wide, three feet high, and approximately 40 inches long, on which parachutes are packed.

Palm. — Hand protector for sewing by hand.

Pan. — A formed tray of wire or sheetmetal; a type of container frame used in Switlik chutes.

Parachute. — The word "parachute" is derived from the Italian verb "para," meaning to shield or protect, and the French word "chute," meaning to fall. The combination of these words form the English noun "parachute," which defines the function of the device affording protection during a fall.

Parachute loft. — Spaces utilized for servicing parachutes.

Parachute rigger. — A person fully qualified to service all aviation lifesaving equipment.

Paraffin. — An inflammable, waxy substance which, when melted and mixed with an equal amount of beeswax, produces a good binding solution to apply to cut webbing ends to prevent fraying of the weave.

Peak. — See APEX.

Periphery. — Outer edge of the canopy; the skirt.

Permeability. — A measure of the rate of flow of air through fabric, denoted in cubic feet of air which will pass through a square foot of fabric in one minute under a pressure drop of one-half inch of water across the fabric.

Pelican hook. — A quick-release device, once used as a means of releasing the canopy from free balloons for exhibition jumps when no container was used with the parachute.

Pilot chute. — A small auxiliary parachute with a collapsible spring steel frame, attached to the peak of the main canopy, inserted under tension in the pack. Used to overcome the area of negative pressure and expedite the emergence of the canopy.

Pilot-chute connector cord. — See BRIDAL CORD.

Pilot cover chute. — A pilot chute which forms a part of the container; upon release acts as a pilot chute.

Pilot-chute flaps. — A 4½ x 11½-inch flap attached to the inside of each side flap. Forms a protection for main canopy from pilot chute frame.

Pocket, rip cord. — Pull ring, hand pull, a fabric pocket which envelops and retains a part of the pull ring. Usually positioned on the left side of the wearer for accessibility in an emergency.

Pore friction. — The friction or resistance offered by the pores of the canopy material to the passage of air.

Porosity. — The state or quality of the fabric being porous, permitting the passage of air; controlled by the weave of the fabric, thus controlling its permeability.

Portable packing table. — A packing table composed of short, light, interlocking sections, thus rendering the table easily portable.

Positive opener. — An attached-type parachute packed in a large, flat container, mostly used in balloons, the name being derived from the use of light wooden rings suspended inside the peripheral edge to facilitate the positive injection of air.

Premature opening. — Accidental "cracking" of the parachute.

Projected area. — That area of the fully-inflated canopy offering resistance to descent. In the standard service-type canopy, the projected area is approximately 55 percent of the total canopy area.

Pull off. — See LIFT OFF.

Pull ring. — See HAND PULL.

Quick-attachable, back, seat, chest. — A parachute of a type usually used in large patrol and bombing planes, generally of the chest type. Plane members are required to wear harnesses at all times, but are relieved of the bulk and weight of the pack which is carried in a readily-accessible place in the aircraft. Some chair chutes are of this type, classified as Q.A. back-seat chutes (QAS), used by pilots of some large patrol planes and for carrier use where the chute remains in the seat, the pilot wearing his individual harness already adjusted. The QAS is rapidly being replaced by the QFS or quick-fit type.

Quick-connector link. — Patented links for use between lift webs and shroud lines, making possible a quick change of harness without use of a sewing machine. (Not yet approved for service use).

Quick-connector link drop test. — Lines made to rapidly connect any canopy for test. Connects links on shroud lines to the drop-test dummy or to a QAC harness for test. By use of these links, any canopy may be tested before attaching a harness. (See DROP TEST CONNECTOR LINK).

Quick-fit hardware. — Hardware so constructed that the harness can be adjusted to any size wearer by four quick pulls on the webbing.

Quick release. — A parachute harness whereby the wearer, on making a water landing or when landing aircraft on carrier, may disengage all connections of harness instantly.

Quick-release box. — The metal box, located on the chest, to which all harness connections are attached when using the quick-release harness.

Quilter release. — British - developed — a spring - driven timing device for use when dropping cargo.

Radial seams. — Seams radiating from vent to skirt. These form the tunnel for shroud lines. Seams which join two gores.

Raft. — See LIFE RAFT.

Rate of descent. — The vertical velocity, in feet per second, of a fully inflated canopy.

Reserve. — An auxiliary pack attached to the harness for premeditated jumps.

Retarder chute. — See HESITATOR CHUTE.

Ribbon parachute. — A parachute made of ribbons usually two inches in width. May be used at high speeds, is very stable, with no oscillations due to extremely high porosity. Extremely large bulk for resistance, and slow opening time. Very low opening shock.

Rib pockets. — Made by sewing a strip of ½-inch herringbone tape over the inside of a radial seam of the pilot chute to form a pocket for the frame rib.

Rigger. — See PARACHUTE RIGGER.

Rip cord. — A locking device which secures the packed parachute within the container and by which the release of the chute is effected. Rip cord consists of hand pull, flexible cable, and locking pins.

Rip-cord cable. — Flexible wire cable connecting the pull ring with locking cones.

Rip stop nylon. — Nylon fabric woven in intermittent box form with three or four additional closely-picked yarns. Designed to prevent travel of a rip or tear.

Safety thread. — Size 24 x 4 cord cotton or equivalent (four to six pounds tensile strength) used to prevent locking pins from working out of release-device cones.

Seams. — (Federal Specification DDD-S-751). Plain lap, joining selvages, type LSa-2. Inter-panel LSc-2 type. Covers, and so forth, LSb-2 type, double needle. LSq-2 type, single needle.

Seat cushions. — Cushions attached to frame side of seat pack. Provides added comfort for wearer. (Cushion shall NOT, repeat NOT, be attached to parachute in packed condition).

Seat strap. — That part of harness sling used as a seat during descent.

Seat type (Seat Service). — A parachute used in aircraft where the pilot or crew members must remain seated in the performance of their duties.

Service type. — The standard type parachute used by the services.

Sewing machine. — A machine for sewing or stitching.

Shock load. — The maximum load or stress to which the parachute and its components are subjected at the instant of inflation.

Shot bag. — A small bag about one inch in diameter and twelve inches long containing lead shot. Used to hold the canopy folds in position when packing.

Shoulder straps. — That portion of auxiliary straps passing over the shoulders.

Shroud and skirt reinforcement. — To prevent tearing action at junction of skirt and cordage, a loop of ½-inch linen tape is formed around the suspension line with each end stitched to the skirt of the canopy.

Shroud lines. — (Suspension Lines). Cordage connecting the harness to the canopy. (On 24-foot chute, 12 continuous lines run from the link, over the canopy and back to the opposite link, furnishing 24 points of suspension from lift webs to skirt.)

Shroud-line holder. — A device having three fingers for positioning and holding the shroud lines at the skirt while packing.

Side flaps. — Flaps located on long sides of container.

Side slip. — A particular maneuver of a canopy which changes the course of a descending chute by pulling down the side of the canopy in the direction in which it is desired to move. Used when landings are hazardous due to ground obstructions, and so forth. The canopy may be slipped to left or right for more desirable landing sites.

Silk. — A protein, built up of various amino acids, which means it will react to both acids and alkalies. As a protein, it provides food for molds, bacteria, small animal life, and so forth. Will burn, but is not subject to flame propagation; has a specific gravity of 1.25, an elasticity of 15 to 20 percent, an average tensile strength of three grams per denier.

Skirt. — See PERIPHERY.

Sleeve. — A long, narrow fabric tube in which some types of ribbon parachutes are placed. Insures proper deployment, positions load and canopy in line before opening shock, and prevents line overs. Its rapid removal from canopy will cause friction burns when used with nylon parachutes.

Smashes. — A place in the fabric where a number of warp yarns have been broken during weaving. This is evidenced by a group of knots slightly protruding from the surface.

Snaps, Harness. — (# 310336, Tensile Strength, 2500 pounds). Used as a fastener to secure the wearer in the harness. One attached to leg strap, one on right side of harness positioned for leg-strap V-ring on right, and one on left chest strap.

Snap, quick-connector. — (# 310661, Tensile Strength, 5000 pounds). Secured, one at each end of the frame side of the container, forming the male part of connections of pack to lift-web assembly of QAC type. Used on QAS harness at end of lift webs for connecting harness with QAS-type parachute.

Specifications. — A statement containing a minute description or enumeration of particulars as of contract terms, construction details not shown on a drawing, and so forth.

Spreader bar (Tension Hooks). — Flat metal hooks permanently spaced the distance of lift-web entry into the container, sliding on sampson cord on packing end of table, connected with shroud links, places canopy and shroud lines under tension for packing.

Square parachute. — A chute made in a square shape or pattern. Very stable, and commonly used for very small cargo.

Stains. — Discolored or soiled spots not easily removed.

Starshell parachute. — A small parachute used in a projectile to support a magnesium candle.

Static line. — A line (wire, webbing, cord) secured to the release device and to a structural part of the aircraft for releasing attached-type, cargo, and paratrooper-type parachutes.

Stiffener. — Flat bars of Phenol fibre, extremely durable and slightly flexible, used to retain shape of pack.

Stitches (Type 301*).* — Commonly called lock stitch. Accomplished with 111W150 sewing machine.

Straight construction. — The method of cutting fabric parallel to warp or filler, not on a bias.

Surgeon's tape. — One-inch silk tape, tubular or flat, sewn into the skirt hem and peak as a reinforcement.

Survivor's kit. — A kit containing essentials for maintaining life and health, dropped to survivors from aircraft.

Tab. — See CORNER TAB.

Tacking. — Method of temporary sewing, with one stitch and tying, for positioning permanent sewing of ripcord housing and pocket.

Taffeta (Weave). — A fine, glossy, uncorded and untwilled fabric. A weave in which the shuttle carries the woof thread over one and under one warp thread. A plain weave.

Tear resistance. — The average resistance of a fabric to tear, tested strip method.

Tensile strength. — The maximum tension, measured in pounds, to which a material may be subjected without rupture.

Terminal velocity. — The greatest velocity that a free-falling body, starting from rest, can attain against the resistance of air at any predetermined altitude. At near sea level, a maximum of 120 m.p.h. has been recorded.

Time lag. — Discovered in the Gottingen Tunnel in Germany in 1918, and was .621 seconds for shocks as applied on opening on hand-woven silk used at that time. Long "staple" method of weaving and bias construction are mostly responsible for duration of this "time lag."

Traveling bag. — See CHAFING BAG.

Triangle parachute. — A chute of triangular shape, supposedly steerable and possessed of a forward speed through still air of four to five m.p.h.

Twill weave. — Method of weaving in which the shuttle carries the woof thread over one and under two or more warp threads.

Unolyn. — Trade name for undrawn nylon. This material has the property of elongating under load without regain, thereby expanding energy.

V-ring. — Forged metal fittings shaped in the form of a V, serving with snap hooks to secure the harness to the wearer.

Vent. — A circular hole in the center of the canopy apex, to relieve pressure of descent.

Ventage. — Air passing through the vent and fabric pores.

Vent collar. — Fabric in the form of a 10-inch chimney attached to the canopy vent.

Vent ring. — A moulded elastic ring four inches in diameter, enclosed in the hem of the vent-collar free end to hold the vent practically closed but free to expand under excessive pressure.

Vinco release. — A device made by the Vinco Company to free parachutes from the AR-8 boat upon water contact.

"W" stitching. — A pattern of stitching used in the attachment of lift webs to connector links. No part of this stitching is sewn directly across — perpendicular to edge of webbing. Sewing straight across webbing has been found to weaken its initial strength.

Warp. — The lengthwise, parallel threads fixed in a loom for weaving.

Wako-mine chute. — A ribbon-type parachute for use on mines.

Water landing. — A parachute descent terminating in the water.

Weave. — See FILLER.

Wind drag. — The open canopy acting as a sail after landing, dragging the parachutist, or cargo.

Webbing. — Woven of linen, cotton, or nylon, used for construction of harness to retain and support the wearer to an inflated canopy.

Zig-zag. — A method of sewing by a machine, using one needle, to make a stitch alternating one right, one left, for single zig-zag, or one right, one center, and one left, for double zig-zag. Cordage is secured to pilot-chute canopy with a double-type stitch; to the main canopy with double-type.

Zipper. — A mechanical method of fastening two pieces of fabric, canvas, or leather together without use of lacings or buttons, by use of a series of small interlocking metal tabs, scoops, or latches positioned by a sliding device.

APPENDIX II

ANSWERS TO QUIZZES

CHAPTER 1

PARACHUTES

1. *d.* 2. *d.* 3. *c.*
4. *c.* 5. *a.* 6. Balloonists.
7. *(a)* Heinecke (German).
   Mears (British).
   Guardian Angel (British).
   Orrs (French).
   S. T. A. (French).
   A. E. F. (American).
   (b) 100 m. p. h.
8. *a.* 9. *b.* 10. *b.*
11. *c.*

CHAPTER 2

"HIT THE SILK"

1. *c.* 2. *c.* 3. *a.*
4. To take maximum advantage of air resistance.
5. At the moment the chute opens.
6. Lack of adequate oxygen, extremely low temperature, and sudden blast of wind caused by the high speed of the plane.
7. *a.*

CHAPTER 3

TYPES OF PARACHUTES

1. One which has no attachments to the aircraft.
2. *b.* 3. *b.* 4. *d.*
5. *d.* 6. *d.*
7. *(a)* Training.
   (b) The back pack canopy is 4 feet larger than standard size; the other is a standard QAC size.

CHAPTER 4

PARACHUTE CLOSE-UP

1. Pilot chute, canopy, shroud lines, pack, and harness.
2. To hasten the opening of the main canopy and to prevent fouling of the main canopy about the wearer's body.
3. Four metal ribs and springs.
4. Pilot chute connector cord.
5. Eight. Twenty-four.
6. Four. Shroud lines.
7. Each line is anchored by zig-zag stitching at several points to the radial seams through which it passes.
8. Vent. To relieve internal air pressure within the canopy at the moment of opening, and to prevent oscillation during descent.
9. When the rip cord is pulled, the pack-opening elastics draw the side and end flaps back to free the chute.
10. Four.
11. To compensate for the short lift web assembly of the QAC.

CHAPTER 5

PARACHUTE WORKSHOP AND EQUIPMENT

1. *d.* 2. *b.* 3. Humidity.
4. At least 12 inches. 5. 24 hours. 6. 60 parachutes.
7. 36 inches. 8. 56 parachutes.
9. Fahrenheit and centigrade.

CHAPTER 6

INSPECTION

1. If blue litmus turns red, acid is present.
2. The apex is secured toward the head of the table, any possible dips and twists are removed, and the chute fastened under tension.
3. Seven years.
4. Wear, deterioration, stains, non-continuity, noncompliance with technical publications, incompleteness, manufacturers' errors, and flaws. Wear.

5. Every 30 days. At least once every six months.
6. Tears, punctures, ruptured seams, and chafed areas in the cloth.
7. 30 inches. 8. The peak.
9. They cause stiffening and fusing of the strands.
10. The pack. 11. 22 pounds. 12. SS, SB, and TB.
13. Two and one-half years.
14. The Bureau of Aeronautics.

CHAPTER 7

MAINTENANCE AND REPAIR

1. Blueprints, Technical Notes, Technical Orders, and Aviation Circular Letters.
2. 301-OSd-2
    - Number of rows of stitches.
    - Type of seam or stitching. (Ornamental).
    - Type of stitch to be used.
3. *(a)* Superimposed seam.
    (b) Edge finishing stitching.
    (c) Lap seam.
    (d) Binding seam.
4. *(a)* Yes if it is fixed type.
    (b) Not if a PR is on hand.
    (c) Yes. (Because the entire strap should be replaced.)
5. Lengthwise of bolt fabric — parallel to the selvage edges.
6. *(a)* Inside (smaller) patch.
    (b) Outside.
7. Sixty-five feet, seven inches.
8. Sewing machines, cutting table, fastener press, measuring tools, wax pot, hand sewing tools, and cutting tools.

9. To render it more readily adaptable, to protect it, and to prevent fraying.
10. To prevent possible damage to the canopy.
11. *(a)* Major.
    (b) Major.
    (c) Major.
    (d) Minor.
12. Replacement.
13. Any of the following cases would necessitate a major repair:
    (a) A tear through a radial seam which has severed the shroud lines.
    (b) A tear through the skirt or vent hems which has damaged the reinforcing tape and webbing.
    (c) A tear extending from one section to another.
    (d) A tear extending from one gore to another.
14. Size "E" silk or nylon thread corresponding to the material being repaired.
15. As much as 50 percent.
16. A sharpened screwdriver.
17. 36 inches. 50 inches.
18. It weakens them by as much as 90 percent.
19. By washing in cold water.

APPENDIX III

QUALIFICATIONS FOR ADVANCEMENT IN RATING

PARACHUTE RIGGERS (PR)

RATING CODE NO. 820

General Service Rating

Parachute riggers service, maintain, and repair aviation survival equipment and flight clothing. They are skilled in the operation of sewing machines and in the procedures for maintaining, as well as instructing in the use of, parachutes, life rafts, life jackets, survival provisions, and special equipment packets, oxygen breathing apparatus, and air-sea rescue equipment carried by aircraft.

Emergency Service Rating

Same as General Service Rating.

Naval Job Classifications

Group code Numbers	Group titles
53500—53599	Airplane accessory repairmen, Miscellaneous
59200—59299	Parachute riggers and repairmen

Qualifications for Advancement in Rating

Qualifications for advancement in rating	Applicable rates PR 820
xxx. 100 PRACTICAL FACTORS	
. 101 TOOLS	
Use tools applicable to servicing parachutes and survival equipment	3, 2, 1, C
. 102 INSTRUMENTS	
Use measuring instruments applicable to servicing parachutes and survival equipment. Use instruments to obtain temperature and relative humidity	3, 2, 1, C
Use instruments for drop testing, such as barometric pressure releases, timing releases, tensiometers, "G" instruments, etc	1, C

	Qualifications for advancement in rating	Applicable rates PR 820
. 103	BLUEPRINTS	
	Read and use blueprints in repairing and modifying parachutes and survival equipment	3, 2, 1, C
. 104	PREMEDITATED JUMP	
	Make at least 1 premeditated, free-fall parachute descent with a parachute personally packed under the direct supervision of a qualified parachute rigger. (At the discretion of the officer-in-charge, this requirement may be waived when such action is deemed necessary for the good of the service.)	3, 2, 1, C
. 105	PARACHUTES	
	Pack all types of lifesaving and cargo parachutes. Pack without assistance or supervision and be willing to perform a jump with a personally packed, and passed as perfect, parachute. Handle, stow, and issue parachutes for flight personnel; maintain records. Set and install all types of fasteners used in survival equipment. Perform minor repairs to parachute canopies and subassemblies	3, 2, 1, C
	Recognize stains commonly found in parachutes in service, determine the correct, noninjurious cleaning agent, and employ the best method to clean the fabric. Manufacture minor subassemblies of parachutes and perform required alterations or major repairs. Rig and load drop-testing dummies in accordance with current AN specifications. Construct various types of lift web and sling assemblies for use with cargo parachutes and cargo to be dropped	2, 1, C
	Conduct a drop test in accordance with current AN specifications	1, C
	Perform major repair operations and rebuild lifesaving equipment	1, C

	Qualifications for advancement in rating	Applicable rates PR 820
.106	SEWING MACHINES	
	Use and "time" all types of standard sewing machines. Perform routine servicing and upkeep of sewing machines	3, 2, 1, C
	Maintain and repair sewing machines	1, C
.107	OXYGEN AND CO_2 EQUIPMENT	
	Perform upkeep on oxygen masks; test oxygen and CO_2 cylinders for proper charge; clean, stow, and issue for service oxygen masks	3, 2, 1, C
	Install and test oxygen cylinders and connections for proper operation	2, 1, C
	Transfer, test, and service all oxygen and CO_2 equipment installed in aircraft in accordance with current specifications	1, C
.108	SAFETY BELTS AND WEBBING	
	Inspect, test, and install safety belts and shoulder harnesses according to AN specifications	3, 2, 1, C
	Manufacture, according to drawings, patterns, and templates, various types of fabric work and webbing assemblies, including safety belts, shoulder harnesses, slings, and hoists used in naval aviation survival equipment	1, C
.109	SURVIVAL EQUIPMENT (GENERAL)	
	Equip and pack all types of life rafts and standard aviation survival equipment; make patches and minor repairs to rubberized fabrics, including rubber life jackets and life rafts; inspect, equip, stow, issue, and make repairs to flight clothing and personal protective or survival equipment	3, 2, 1, C
.110	SUPPLIES	
	Employ proper supply procedures for procurement, custody, issue, storage, and accounting of equipment	3, 2, 1, C

	Qualifications for advancement in rating	Applicable rates PR 820
.111	RECORDS AND REPORTS	
	Prepare records and reports	3, 2, 1, C
.112	PUBLICATIONS	
	Use applicable publications, technical letters, etc., for maintenance and employment of aviation safety and survival equipment	3, 2, 1, C
.113	SUPERVISION	
	Supervise and train personnel; demonstrate procedures and various techniques to be employed in the use and maintenance of parachutes and all survival equipment	1, C
	Organize and administer loft or repair facilities for aviation survival equipment	C
xxx.200	EXAMINATION SUBJECTS	
.201	TOOLS, WEIGHTS AND MEASURES	
	Kinds and uses of tools used in aviation safety equipment repairs; weights and measures involved in testing strengths of materials; manner of obtaining temperature and relative humidity and their significance for stowage of perishable safety equipment; the approximate weights of principal survival equipment	3, 2, 1, C
	Methods used to operate and record readings of all types of instruments used in drop testing and parachute laboratories	1, C
.202	PARACHUTES	
	Component parts, materials, manner of construction, care of handling fabrics, operation of service and cargo types, manner of packing and stowing	3, 2, 1, C
	Methods used to detect stains, clean and make major repairs to parachutes and subassemblies. Procedures used to set up a parachute loft and to conduct drop tests	1, C

Qualifications for Advancement in Rating—Continued

Qualifications for anvancement in rating	Applicable rates PR 820
.203 SURVIVAL EQUIPMENT	
Nomenclature and procedures for testing and installing safety belts and shoulder harnesses. Types and uses of life rafts and survival equipment packets; techniques of packing survival equipment and life rafts. Types and methods of testing rubber life jackets	3, 2, 1, C
Types of oxygen installations and equipment, manner of servicing, testing, and maintaining oxygen equipment. Safety precautions involved in handling oxygen	2, 1, C
.204 SEWING	
Nomenclature, terms used, and methods of servicing sewing machines. Types of seams and stitching	3, 2, 1, C
Maintenance procedures and manner of requiring sewing machines	1, C
.205 MATERIALS	
Types, styles, and sizes of slide fasteners, threads, and needles; cleaning materials and their uses and precautions; properties of cotton, silk, rayon, leather, nylon, and webbing: their weaves, tensile strengths, durability, and general characteristics. Properties of pure and synthetic rubber and rubber cement	3, 2, 1, C
.206 SURVIVAL TECHNIQUES	
Procedures for jumping and for handling all survival equipment	1, C
.207 SAFETY PRECAUTIONS	
Safety precautions to be observed in operating sewing machines and other equipment pertaining to the repair of survival equipment	3, 2, 1, C
.208 SUPPLIES	
Basic supply procedures to be followed for procurement, custody, issue, storage, and accounting of survival equipment	3, 2, 1, C

Qualifications for Advancement in Rating—Continued

	Qualifications for advancement in Rating	Applicable rates PR 820
.209	RECORDS AND REPORTS	
	Records kept and reports submitted	3, 2, 1, C
.210	PUBLICATIONS	
	General content and use of technical bulletins, publications, and catalogs pertaining to aviation survival	3, 2, 1, C
.211	ORGANIZATION	
	Organization of Air Department at own station	3, 2, 1, C
	Organization of naval aviation	1, C
xxx.300	NORMAL PATH OF ADVANCEMENT TO WARRANT GRADE	
	Parachute riggers advance to Warrant CARPENTER 7712 (*Aviation Survival Technician*), and act as assistants to Engineer Officers as Material Officers in charge of aviation safety and survival equipment and flight clothing	----------

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